# Chemical & Process Engineering

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**TOPICS OF THE MONTH:**
What about biochemical engineering?; Beer six times as fast; Liquid flow in grid-packed towers; A hundred years of Glover towers; To lighten our darkness; Ion exchange in gelatine production; Chemical industry in Bulgaria; Fresh thoughts on pressure vessels; Wanted—more instruments 1

**HYDROGEN PEROXIDE—BIG NEW 'AUTOXIDATION' PLANT AT WARRINGTON** ... ... ... 5

**GAS CLEANING (Special Feature):**

**NEW APPROACH TO WET WASHING OF INDUSTRIAL GASES** *by C. A. Bainbridge* ... ... ... 8

**TREATMENT OF GASEOUS EFFLUENT IN FERTILISER WORKS** ... ... ... ... ... ... 10

**DEALING WITH NOXIOUS GASES** *by W. A. Damon, C.B.E., B.Sc., F.R.I.C., M.I.Chem.E.* ... ... ... ... 11

**GAS CLEANING DEVELOPMENTS IN BRIEF** ... 13

**CHEMICAL ENGINEERING DATA BOOK** ... ... 15

**CUTTING THE COST OF HEAVY WATER** *by M. C. Reece, B.Sc., Ph.D.* ... ... ... ... ... ... 16

**PETROCHEMICAL ENGINEERING ACHIEVEMENT AT FAWLEY** ... ... ... ... ... ... ... 19

**SAFER MANUFACTURE OF EXPLOSIVES** ... ... 22

**AUTOMATIC PROPORTIONING PLANT FOR FERTILISER MANUFACTURE** ... ... ... ... 24

**TECHNOLOGY NOTEBOOK** ... ... ... ... 24

**WHAT'S NEWS ABOUT PLANT, EQUIPMENT, MATERIALS AND PROCESSES** ... ... ... ... 25

**RECENT PUBLICATIONS** ... ... ... ... ... 32

**NOMOGRAM: CONVECTION AND RADIATION COEFFICIENTS FOR AIR FILMS** *by D. S. Davis* ... ... 33

**MEETINGS**... ... ... ... ... ... ... ... ... 33

**COMPANY NEWS** ... ... ... ... ... ... 34

**WORLD NEWS:**
Netherlands; Formosa; South Africa; Australia; United States; Hungary; Honduras; Malaya; Mexico ... ... 35

**C.P.E. CHEMICAL PLANT COST INDICES** ... ... 35

**PERSONAL PARAGRAPHS** ... ... ... ... 36

**RECENT BRITISH PATENTS** ... ... 36

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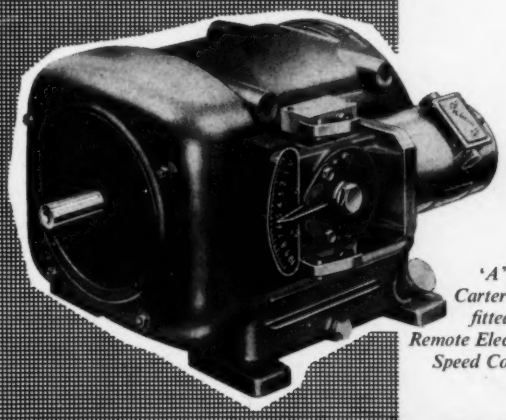

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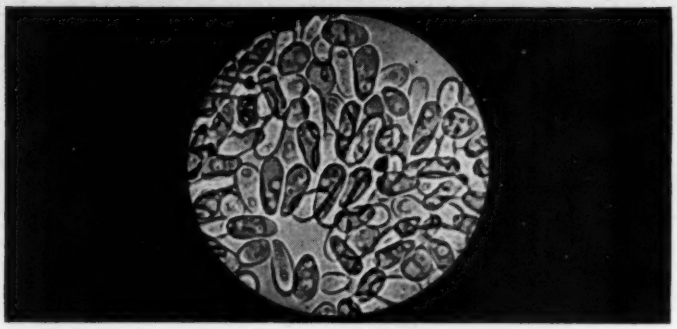

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# TOPICS OF THE MONTH

### *What about biochemical engineering?*

THE recent decision of the Council for Scientific and Industrial Research to disperse the work of the microbiology group at the National Chemical Laboratory has caused dismay and even indignation in some quarters. However, leaving aside the manner in which this decision was arrived at, and looking at it impartially in the light of the country's scientific needs, it might well be a good thing if industrial microbiological research were carried out in university departments as the Council suggests. It might also give an impetus to the further advance of ' biochemical engineering,' or applied microbiology, through the suitable arrangement of university departments. It is becoming increasingly recognised that there are a number of unexplored possibilities in the application of microbiological knowledge to industrial processes. Microbiologists and chemical engineers must work together on this. To see the possibilities we have only to look at the advances made in fermentation processes for the production of industrial chemicals, antibiotics and food, penicillin production being an outstanding example of chemical engineering applied to biosynthesis.

There seems a good deal to be said for the D.S.I.R. Council's contention that an industrial microbiology team is able to do the best and most effective work when it operates within a research laboratory concerned with the technology served by the team. The truth of this is in no way diminished by the fact that the slim band of scientists at the National Chemical Laboratory who have been bearing the main burden of microbiological research in Britain have done some commendable work. Apart from the National Collection of Industrial Bacteria, which is to be transferred to the Torry Research Station, Aberdeen, and the microbiological work on metallic corrosion, which is to be retained at the N.C.L., the main investigations of the microbiology group have been concerned with sulphur bacteria and methane-producing bacteria. The work on sulphur bacteria resulted in the setting up of the pilot plant for the production of sulphur from sewage sludge at Beckton, London, as was described in CHEMICAL & PROCESS ENGINEERING, 1957, **38** (3), 111-112.

### *Beer six times as fast*

AS a production technique continuous fermentation offers many apparent advantages over batch processing. In a contribution to the December issue of our associate journal *The Manufacturing Chemist* R. Levin observes that interest in this technique is by no means confined to the antibiotics industry; for example, the Brewing Industry Research Foundation at Nutfield, Surrey, has devised an apparatus on the laboratory scale whereby fermentation can be made continuous, with fresh additions of wort constantly being made and the fully fermented beer being withdrawn daily. The process is claimed to be markedly superior to conventional brewing in speed of production—at the most favourable temperature beer is produced six times as fast under the new system.

There are still many practical problems to be overcome before continuous fermentation can be adopted as a routine method of producing antibiotics. Mr. Levin points out that one notable difficulty is the unfortunate habit of some organisms to revert to non-antibiotic producing forms under conditions of continuous fermentation. By judicious handling of the fermentation conditions this change may in some cases be prevented. Other important problems are contamination, the need for a continuous supply of sterile mash and subsequently for continuous extraction. In other words, for the best effects, continuous fermentation should be part of a continuous production process, commencing with a steady feed of raw materials and ending with equally regular isolation of the active substance.

Is it true that, although the continuous fermentation of some antibiotics is now technically possible, industry is not yet ready to accept the method ? This idea was suggested by a speaker at the 7th International Congress on Microbiology, held at Stockholm recently, who reported briefly on continuous streptomycin fermentations on the 30- and 3,000-litre scale. He had apparently accomplished runs of up to 1,000 hr. with a product yield of 75 to 80% of that normally obtained with the batch process.

### *Chemicals in Bulgaria*

THE chemical industry in Bulgaria is to get priority rating during the third five-year plan which started in 1958. In 1957 its output nearly trebled in comparison with 1952 and was 23 times as high as in 1937. Today the country produces considerable quantities of nitrogen fertilisers, sulphuric acid, soda ash, caustic soda, and other chemicals, as well as antibiotics such as penicillin and biomycin. By the end of 1962 chemical production is to increase 2½ times to give 330,000 tons p.a. of nitrogen fertilisers; 560,000 tons of phosphate fertilisers, and 17,500 tons of carbamide. Other projects include the building of a large cellulose and paper works, while the existing lead and zinc plant is to be considerably expanded and a new plant with an annual capacity of 30,000 tons of zinc is to be built. A copper smelter and refinery with an annual capacity of 15,000 tons is shortly to be completed.

Last year the country's output of artificial fertilisers increased by about 50%, attaining the figure of 70,000 tons of bonded nitrogen—equal to 350,000 tons of

nitrogen fertilisers with 20% of nitrogen. In the course of this five-year period the first stage of the nitrogen fertiliser plant near Stara Zagora, with an annual capacity of about 300,000 tons, is to be completed.

The chemical works at Dimitrovgrad have recently added sodium nitrite to their range of products, while the ' Karl Marx ' State Soda Plant at Devnya is producing soda ash, caustic soda, tartaric acid, calcium chloride and related chemicals.

### *A hundred years of Glover towers*

THIS year's centenary of the first tower built by John Glover for sulphuric acid manufacture gives us an opportunity of looking back to see the effect of this innovation on the production of this key chemical. While in 1859 the chemical industries of Britain and France were linked or associated in the newly discovered coal-tar dyestuffs industry, the combination of the Glover and Gay Lussac towers proved an even more remarkable link, enabling the production of a more concentrated acid required in the new dyestuffs industry. It was when Glover added his tower to the lead chamber plants, begun by John Roebuck of Birmingham a century before, that the whole pattern of sulphuric acid production was changed, providing the cheaper concentrated vitriol still demanded by the superphosphate industry today.

In 1835 Gay Lussac, who with Clément managed the chemical works of St. Gobain operating the Leblanc soda process, had designed his tower which reduced saltpetre consumption from 9 to 3% of the weight of sulphur used. Nitre prices were low, however; hence English vitriol producers did not take to the innovation at first. Then a rise in nitre prices in the 1860s brought a widespread adoption of the Gay Lussac and Glover systems both in Britain and abroad, a phase in which the use of pyrites in place of brimstone developed to a figure of several hundred thousand tons and proved yet a third contribution to economic production.

John Glover of Wallsend-on-Tyne was a plumber's assistant before going as laboratory chemist to the Felling Chemical Works while studying chemistry at the local Mechanics Institute. In 1842 he became manager of the Washington Chemical Co., at whose works he designed and constructed the first tower of 1859. Some time before this the idea came to him of ' breaking the affinity ' between sulphurous and nitrous compounds in Gay Lussac's acid without repeated operations of cooling and reheating as then carried out. Glover had been erecting a vitriol works for Hugh Lee Pattinson whose process for desilverising lead is well known, and it was then that the idea of a tower for denitrating and concentrating vitriol came to him. The first design was of firebrick with fire tiles as packing within the tower, while in 1861, at Wallsend, Glover tried a lead-lined tower.

Critics of his tower process were many at first, maintaining as they did that the tower was too fragile for taking wear and tear and that the tower took three days to warm up. Despite such opposition Glover persisted, seeking improvements or modifications until by 1864 he had arrived at the tower much as we know it today.

Glover did not patent his invention, although some chemical historians believe he did; on the contrary he preferred to see it widely adopted, as he demonstrated its application to all and sundry. Some Tyneside acid producers seem to have tried adding their own modifications, all of which proved useless and even detrimental, since such failures added to the disfavour created by critics of the scheme.

The rise of Glover towers in Britain and Germany was a measure of progress in the heavy chemical industry. At Widnes in 1867 there was still no sign of a tower, though every hundred tons of sulphur burned required 15 tons of nitre. At the end of 1868 the first tower appeared in Lancashire, others followed at Gaskell & Deacon's works and elsewhere, while Hurter, chief chemist of the United Alkali Co. who had been a strong critic, did not discontinue using the Glover towers in the company's works. When Lunge published an account of the Glover tower in 1871 there came a general adoption in Germany despite such critics as Kuhlmann with their mistaken belief that hot sulphur dioxide reduced nitrous fumes to $N_2O$ or even nitrogen. It was significant that with Glover towers adopted on an increasing scale the old lead concentrating-pans were banished, the last ones disappearing in 1871 from Gaskell & Deacon.

### *Pollution on the air*

THE prospect of being subjected to a barrage of questions from local inhabitants about air pollution, not merely at an open meeting but in a radio broadcast, is one at which the most hardened industrialist might quail, but the representatives of Mobil Oil Co.'s Coryton refinery who underwent this ordeal in a B.B.C. transmission of December 15 did not seem unduly perturbed. Those who are troubled with vapour and fume problems on a smaller scale may find a crumb of comfort in the fact that, according to the answer given to one visitor by Mr. R. B. Fraser, the refinery manager, some £30,000 has been spent on mechanical seals alone at Coryton, while another £6,000 went on a flame burner to cut out air pollution from the 280-ft.-high catalytic cracker. This is apart from the money spent on floating-roof tops for oil storage tanks, special precautions in connection with the burning of foul gas, and removal of the inevitable refinery waste products.

Mr. D. H. Tullis, superintendent of the technical division, was faced with a poser from a local government official who wanted to know why pollution was most apparent in the early hours of the morning, in view of the fact that the refinery operates 24 hours a day. However, he came out of it bravely with a suggestion that such a state of affairs could be brought through meteorological conditions creating temperature inversion conditions which would tend to prevent diffusion of the smell into the upper atmosphere.

### *Fresh thoughts on pressure vessels*

MANUFACTURERS of pressure vessels who have had reason to criticise the standard in B.S. 1500, because the design stresses imposed by this standard were so severe as to handicap exports, will be gratified to see that the latest B.S.I. publication on this subject takes into account some of the industry's comments. In publishing it, the British Standards Institute acknowledges the need to lower factors of safety but points out that this cannot be achieved without adequate data. It is encouraging to learn from the Institute that steps are being taken to obtain these data, with a promise of corresponding further action.

The new publication* deals with carbon and low-alloy steel pressure vessels and supersedes the portions of B.S. 1500 : 1949 that covered this subject. Notable new features are an appendix on vessels for low-temperature operation and another giving examples to illustrate the application of the standard. In a foreword, the B.S.I. declares its intention to keep the standard under review and to incorporate any modifications that may be found desirable from time to time.

### *More instruments wanted*

LAST month we quoted, in these columns, the remarks of an American authority on the need for more and better instruments to meet the needs of scientific and technological progress. British users of instruments, both for research and for process purposes, are worse off than American, to judge from remarks made at the 7th S.I.M.A. Convention held at Harrogate recently. Thus, Dr. R. J. Taylor, research manager of Unilever Ltd., gave instances of a variety of instruments which the company had to produce for itself because of the lack of instrumentation suitable for research in the Unilever field. Some of the instruments were already available on the American market but he was under the impression that the British scientific instrument manufacturer was not prepared to go into production until he saw a large market.

One Unilever need, according to Dr. Taylor, was an instrument to measure the colour variations between liquids, this being the means of determining the amount of refining necessary. They were still using the old Lovibond tintometer as there were no satisfactory new instruments on the market. Another measurement of great importance in many industries dependent on sale by weight is the control of moisture limits. Here again, he pointed out, no satisfactory moisture-measuring control equipment is available.

Comparisons with America were rife at this conference and Mr. C. W. Munday, of The Distillers Co. Ltd., raised the problem of the long delay between the conception of an idea and the instrument working on the plant. He gave two examples of instruments of which the principles had been worked out in Britain but in each case the Americans had gone into production long before British instrument makers had started. However, there seems to be some truth in the argument, raised by more than one speaker at this meeting, that the Americans had been able to get ahead because they had continued development during five years of war whereas the British industry had been fully committed to the war effort.

*B.S. 1500 : 1958, 'Fusion-welded pressure vessels for use in the chemical, petroleum and allied industries' (Part 1: Carbon and Low Alloy Steels), pp. 133, 40s.

### *Liquid flow in grid-packed towers*

THE irregular arrangement of a random packing in a column makes it an awesome task to try to predict the degree of liquid spread, but with grid packings, which are of a more orderly construction, the prediction of liquid spread should be possible if the spreading mechanism is known. Yet, although grid-packed towers have been used extensively since about 1869 as gas washers, absorbers, water coolers, etc., little is known about liquid distribution in such packings.

Attention has been drawn to this matter by Dr. J. W. Mullin (University College, London) in a paper presented to the Institution of Chemical Engineers last month. Dr. Mullin presented the results of a series of investigations on the distribution of liquid over slat elements. It has been found possible to predict with reasonable accuracy the liquid distribution, in terms of a packing constant, by means of simple equations based on the packing dimensions. The increase in liquid spread due to the employment of a staggered grid arrangement can also be estimated.

The amount of liquid mixing within a grid packing is unrelated to the liquid spread, as determined by the packing constant. This is due to the fact that very little mixing occurs between the top-edge layers of liquid on the slats. Countercurrent air flow in a grid packing has little effect on either the liquid spread or liquid mixing at rates below the loading point.

### *Ion exchange in gelatine production*

IN the manufacture of gelatine, which is now used in numerous specialised fields of industry, one of the problems is the removal of ions which cause trouble in many applications. The use of ion-exchange processes to eliminate these ions is said to give a number of advantages.

Gelatine is prepared from the protein collagen, which is obtained from bones, cartilage, tendons and connective tissues from slaughter-houses. The conversion of insoluble collagen to gelatine is accomplished by the addition of water and acid to the raw materials, and heating the mixture. The crude gelatine frequently contains a number of extraneous materials, chlorides, sulphates and phosphates being present in ionic form from acid and bones, while sodium, potassium and calcium cations have gone into solution from bones, tissues and body fluids. Traces of phosphorylated amino acids, fatty acids, lipids and other biochemical compounds are also present in this liquor.

Various grades of gelatine are produced which can

be blended to produce gelatines of the required range of *p*H and mineral content. The production of these grades, before blending, is achieved through the use of ion-exchange resins in either batch or column operations. According to a recent technical bulletin of Rohm & Haas Co., U.S.A., in which these operations are discussed, carboxylic cation-exchange resins have been found useful for $Ca^{++}$ pick-up primarily. *Monobed*, or a two-bed system with *Amberlite* IR-120 (H) and *Amberlite* IRA-400 (OH), IR-410 (OH) or IR-45 (OH), is used to produce the mineral-free grades, while *Amberlite* IR-45 (OH) alone can be used to remove hydrochloric acid in the preparation of photographic-grade gelatine. High-*p*H gelatine, on the other hand, is more often produced by treating the gelatine solution with *Amberlite* IRA-400 (OH) or IR-410 (OH) for removal of chloride and other anions.

Since the gelatine solution must be passed while hot through the ion exchanger, it is necessary that only those resins be used which will withstand the maximum temperature (about 140°F.) of the liquid gelatine solution. Of further interest in the selection of the proper resin is the ability to handle $CO_2$. Weakly anionic resins pick up $CO_2$ early in use, but as the cycle continues, the weakly associated $CO_2$ is replaced with stronger anions, and the $CO_2$ itself is liberated as a gas. This condition disrupts the orderly operation of the exchange column, producing channelling in the bed and reducing the efficiency of the operation.

One of the chief benefits of ion-exchange treatment is the ability to produce gelatines at their natural isoelectric points. Having both carboxyl and amino groups in their structure, amino acids behave like amphoteric compounds and ionise both as acids and bases. However, the degree of acidic and basic ionisation is dependent upon *p*H. Each amino acid is characterised by a hydrogen-ion concentration at which the acidic and basic ionisation is equal; this *p*H is called the isoelectric point. Oddly enough, the gelatine from any one particular source, such as bone marrow, pork skin, etc., has a characteristic isoelectric point. It follows, therefore, that the source of an unknown gelatine sample can be identified by passing the specimen through a *Monobed* exchanger and subsequently measuring the *p*H of the treated liquid.

### *To lighten our darkness*

IN many a well-organised works where the works manager makes his beaming way through the orderly lines of equipment, nodding approval at this or that sign of efficiency and scrupulous attention to duty, high above his head, like so many swords of Damocles, hang heavily corroded lighting fittings: a potential source of disaster. It is not so much that they might fall on his head in the literal sense as that corroded fittings, as well as fittings that are not properly protected against fire and explosion hazards, are always dangerous. Although this fact is generally recognised in those industries where atmospheric corrosion is a serious matter or where flammable materials are handled, the correct choice and installation of lighting fittings is often assumed to be a much simpler business than it actually is.

Illumination on the subject comes, appropriately enough, from the Illuminating Engineering Society, who have recently published a report* dealing with the kinds of explosion and fire hazards that are likely to crop up in lighting fittings, and with some conditions of corrosion which might affect their safe operation. This points out that the first essential whenever severe corrosion is expected is to choose carefully the positions where the lighting fittings are to be mounted. For example, fittings should never be mounted in pockets in the ceiling, particularly if steam is present, otherwise they are likely to operate constantly in moist air even though they may be remote from the source of steam. For the same reason, improving the ventilation of the roof space will often reduce corrosion.

The second essential is to choose a fitting suited to the particular conditions. In very corrosive situations special corrosion-resistant lighting fittings are required, although some engineers prefer to use cheaper units and replace them regularly. The report notes that plastics are finding increasing use for lighting fittings in corrosive situations; however, where organic chemicals are present plastics should be used with discretion, as a wrong choice may quickly result in breakdown.

The third of the three essential factors in combating corrosion in a lighting installation is to make sure that the wiring system as well as the lighting fittings will withstand the conditions. Positioning of cable runs, switches and other control gear should be such as to avoid exposing the cable to rain, dripping or condensed water, or to corrosives.

On the subject of flameproof lighting fittings, the report points out that, as these are limited in temperature rise to 50°C., they should be installed in the correct operating position, normally with the cap of the lamp upwards. Installation in any other position may not invalidate the certificate but it may affect the temperature distribution. Another point is that the emphasis that is necessarily placed on the robustness and reliability of flameproof fittings may sometimes lead to the need for good light distribution being overlooked.

Increasing use is being made of flameproof handlamps for temporary lighting in flammable or explosive locations. Where possible these should be connected to a low-voltage supply of not more than 30 v. Where this is not practicable it is advisable to equip the associated socket outlet with an earth-leakage protective device. There are other precautions to be observed for the flexible cable and earthing arrangements.

These and many other facts in the report, including some tabulated examples of lighting arrangements for particular problems should be useful not only to engineers and contractors called upon to advise on or install lighting in hazardous situations, but also to the industries concerned.

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* 'Lighting in Corrosive, Flammable and Explosive Situations,' I.E.S., 32 Victoria St., London S.W.1, price 5s.

# HYDROGEN PEROXIDE

## BIG NEW 'AUTOXIDATION' PLANT AT WARRINGTON

*The first of its kind in Europe, and probably the largest in the world, Laporte Chemicals' new £2½-million hydrogen peroxide plant at Warrington, Lancs., uses a process that is strikingly different from the electrolytic process used hitherto. Some salient features are:*

**★ Laporte think the process is a winner, since it not only saves considerable quantities of electricity, steam and cooling water, but is also more productive than electrolysis.**

**★ An analogue computer played a vital part in the chemical engineering of the plant—it is believed that this is the first time in Britain that a whole process of this complexity has been successfully simulated.**

**★ Aluminium is used extensively for process vessels and equipment: the major vessels are probably the largest ever fabricated in this metal, being up to 80 ft. high and 12 ft. in diameter.**

**★ The plant is almost entirely in the open and, wherever possible, corrosion is forestalled by separating the aluminium columns and piping from contact with foundations and mild-steel structures by the use of PVC sheet and roofing felt.**

**★ The equivalent of 10 miles of copper tube has been used for instrument air lines.**

IN recent years there has been an increasing interest in hydrogen peroxide, not only for use in bleaching and the manufacture of other per-compounds, but also for use as a propellant and as a reagent for organic synthesis. This has led to the development of methods of manufacture other than by electrolytic processes developed over the last 50 years, particular attention being given to the use of organic intermediates, especially substituted anthraquinols, which autoxidise to form hydrogen peroxide.

The process developed by Laporte Chemicals Ltd. is based on the use of 2-ethyl anthraquinone in solution, using a continuous and cyclic process for which the major raw materials are hydrogen, atmospheric oxygen and water.

### Hydrogen plant

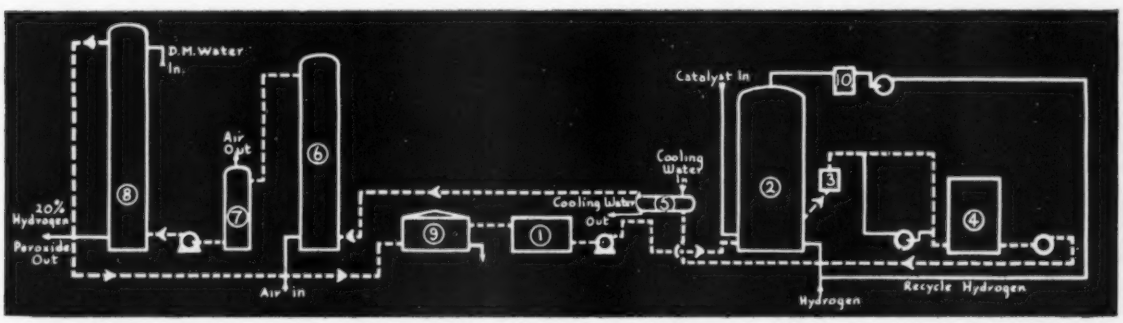
Hydrogen is made by cracking butane, supplied from Stanlow oil refinery, the plant being supplied and erected by the Power-Gas Corporation Ltd. In the presence of steam and a catalyst, the butane yields hydrogen and carbon monoxide; the latter is removed by reacting with steam over a catalyst forming hydrogen and carbon dioxide. The carbon dioxide, removed by scrubbing with mono-ethanolamine, is used as required as a purge gas in the autoxidation process.

The hydrogen is passed over a catalyst, when the carbon monoxide content is further reduced with a formation of methane, and then compressed for use in the process.

The hydrogen make-up compressors are single-stage, double-acting, dry-cylinder machines fitted with gas-proofed auto-governors and unloading equipment, and carbon piston rings and carbon glands on piston rods. These machines are capable of delivering about 400 cu.ft./min. at a delivery pressure of 50 p.s.i.g.

### Autoxidation

The autoxidation process organic cycle consists of two identical units which operate in parallel up to the extraction stage where solution from both streams mixes. Hydrogenation is carried out in vertical vessels using palladium on an inert support in free suspension as the catalyst, this being manufactured on the site; the catalyst is suspended using a stream of hydrogen which is passed through the reactor in excess of the theoretical requirement, the excess being recircu-




**Simplified flow diagram of the autoxidation process organic cycle at the Laporte Chemicals hydrogen peroxide plant. Numbered plant items are: (1) hydrogenator feed tank, (2) hydrogenator, (3) hydrogenator filter vessel, (4) oxidiser feed pump tank, (5) coolers, (6) oxidiser, (7) oxidiser knock-out drum, (8) extraction column, (9) treatment, and (10) hydrogenator degasser.**

lated together with fresh hydrogen. Nash Hytor compressors are used for recycling hydrogen in the system, these machines being in cast iron with liquid seals, and capable of delivering some 400 cu.ft./min. at a delivery pressure of 35 p.s.i.g.

Catalyst is added to the reactor at the rate necessary to maintain the required rate of reaction. The catalyst used was specially developed by Laporte and, since it decomposes hydrogen peroxide, a novel filtration system was evolved to ensure that no catalyst penetrates to the oxidation stage.

As both the hydrogenation and oxidation reactions are exothermic, the filtered solution is cooled before passing to the oxidisers. These are vertical vessels, and solution and air are fed to the base so that flow is concurrent. The compressors used to supply air for the oxidation stage are high-speed rotary machines which run with fine clearances between the rotor tips and casing. The drive speed is 1,480 r.p.m., which is raised through a speed-increasing gearbox to a rotor speed of 5,880 r.p.m. These machines can deliver more than 3,000 cu.ft./min. at 40 p.s.i. delivery pressure.

The gas/liquid mixture leaving the top of the reactor is separated, excess air passing through active carbon beds for recovery of evaporated process solvents before passing to atmosphere. The solvent recovery plant includes four vessels, two of which are on line at any one time, the others being reactivated by steaming. There are 14 pumps in use for circulating solution and these are fitted with mechanical seals.

Hydrogen peroxide is extracted from the organic solution using counter-current flow in columns fitted with perforated plates. As the organic solution is less dense than water it is fed to the base of the columns. The aqueous feed is de-ionised water, prepared with mixed resin bed exchange units, to which a stabiliser and corrosion inhibitor are added. The aqueous product, which is withdrawn at a constant rate, contains approximately 20% hydrogen peroxide; after passing through a treatment stage for removal of dissolved organic compounds it is held in run-down tanks for checking of quality.

The extracted organic solution passes to a storage tank before being returned to the hydrogenator.

## Distillation

The 20% hydrogen peroxide may be used directly for certain purposes, but it is normally further purified and concentrated to 50 to 90% hydrogen peroxide by distillation. The vaporisers are of the vertical tube and shell type with recirculation, the vapour/liquid mixture passing to a separator. The vapour is fractionated in a column using direct reflux, the columns either being fitted with West plates or packed with ceramic rings, to yield a product with a concentration maintained at the desired level in the range 50 to 70% hydrogen peroxide. The overhead product, substantially water vapour, is condensed using jet spray condensers. Distillation is carried out at reduced pressure, the pressure being maintained using steam ejectors.

Part of the production from these stills is purified further and converted to 85 to 90% hydrogen peroxide (high-test peroxide, or HTP). Hydrogen peroxide solutions are delivered from site in 99.5% aluminium rail tankers, or by road in smaller containers.

LaBour self-priming pumps are used throughout for pumping hydrogen peroxide, these being constructed in aluminium alloy.

## Instrumentation

The whole of the plant is controlled from a central panel which is some 22 ft. long and is divided into (*a*) a graphic representation of the plant with miniature instruments indicating physical values of flow, level, etc.; (*b*) an alarm section; and (*c*) a more conventional panel which carries instruments measuring temperatures, gas analyses and tank contents. Owing to the inflammable nature of the liquids and vapours in the plant, pneumatic instruments have been used wherever possible.

Flow metering is by differential-pressure transmitters, using orifice plates as primary elements. Flow controllers are of the three-term, force-

## ANALOGUE COMPUTER SOLVED PLANT PROBLEMS

The successful simulation of Laporte's new autoxidation plant by analogue computer, taking into account settings, pipe lags, pumping and other characteristics, provides a striking demonstration of how analogue computers can help chemical engineers in the design of industrial plant. Through close co-operation between Laporte's physicists, who undertook a detailed analysis of the physics involved in certain complex portions of the plant, and the computer team of E.M.I. Electronics Ltd., it was possible to provide full start-up and shut-down procedures for the plant, together with controller settings throughout and overall phase and stability margins — all well in advance of the plant's completion.

Turning hours to minutes by means of a 60 : 1 time compression factor on the computer, it was soon found that simple proportional control on the seven subsidiary loops achieved the required stability, and that the pumping capacities were adequate. Step injections of flow and pressure variations allowed the rate of disturbance propagation through the system to be observed. In this way the variation in gain in the forward and backward paths, and the non-linearities of the system resulting from positive and negative displacements, were effectively highlighted.

To achieve this object, E.M.I. and Laporte teams, working together, had to reduce the dynamic mass balance of the plant's closed-loop process to 16 equations suitable for simulation on the computer. These equations took into account the transport lag and damping effect occurring at each of the 24 extractor column plates, the gas compressibility in the absorber column and the physical limits on controller responses and valve positions.

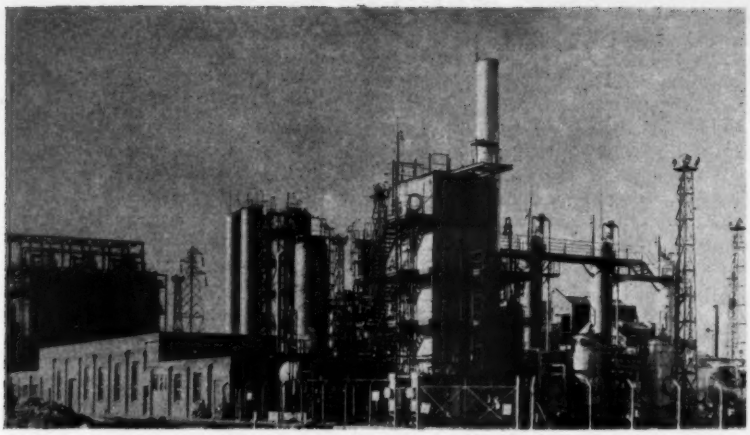
First results of this simulation did not reveal the pilot plant's instability. Further investigation, however, revealed that certain inherent lags were more critical than at first realised. When these were presented correctly to the computer it gave results that checked with previous observations, and prepared the way for scaling up to simulate the whole plant.

In studying the scale-up to full plant, E.M.I.'s team found that, because the non-linearities of the pilot plant were not serious, a linear relationship could be used. Hand integrations were necessary to convert the partial differential equations of the reaction columns to a form involving only time as an independent variable, and enabled a single four-terminal network to be realised for each portion of the plant.

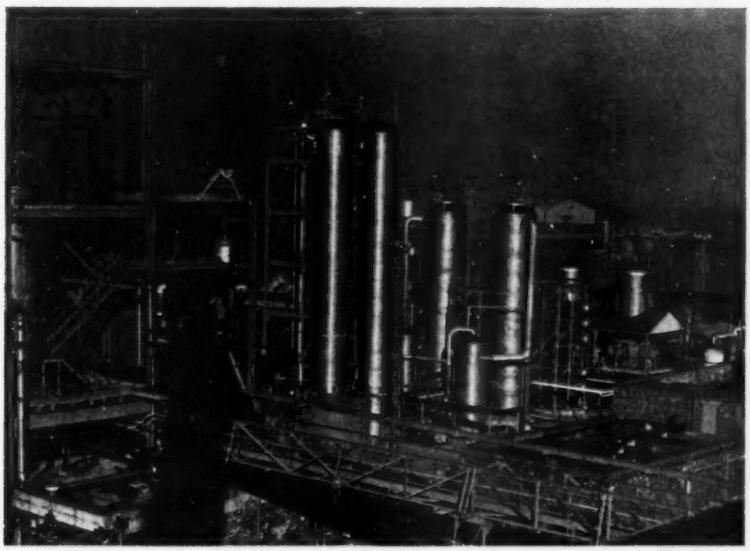
A feature of the computer used is that the normal electro-mechanical servos have been eliminated by the use of a time division variable mark-space multiplier system. One variable controls the amplitude of a train of rectangular pulses and the other proportions the mark-space ratio. The mean amplitude gives the products of the two inputs, which can be integrated as required.

Employing this system, E.M.I. was able to generate those non-linear functions that were products of time variables and to utilise diode function generators to provide the rest.

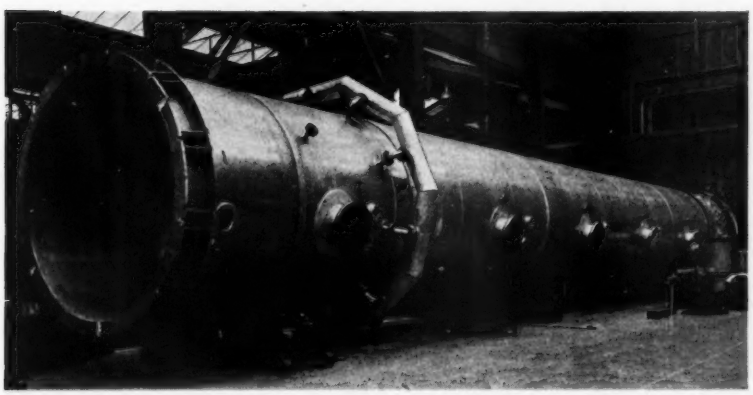
The whole computer simulation study was completed in two months at a cost of less than £3,000.



**A general view of the plant at Warrington, showing, in front, the hydrogen plant where butane is cracked in the presence of steam and a catalyst.**



**Another view of the plant, giving an idea of the size of the extraction columns, at the bottom of which is the demineralised-water tank.**



**One of the extraction columns in aluminium, 80 ft. long and 9 ft. in diameter, is seen here at the works of the A.P.V. Co. Ltd. before delivery to the site.**

balance type, mounted locally to the control valves. Four-line systems convey various impulses back to the miniature receivers on the control panel. The receivers are all fitted with auto/manual facilities.

Differential pressure transmitters have also been used for pressure measurement in a number of the process vessels. Facilities were included to enable the pressure controllers to be mounted either on the plant or in the control panel itself. Levels are controlled by means of displacer-type level controllers each fitted with two separate pneumatic systems: one for control and the other for transmission to ribbon-type indicators in the control room.

Control valves range from ½-in.-bore, bellows-seal, single-seated valves up to and including 10-in. double-seated, stainless-steel control valves, each weighing some 900 lb. All diaphragm valves above 2 in. are fitted with valve positioners. Conventional three-way control valves with quick-acting characteristics are used for certain purposes, but these are driven by power cylinders instead of diaphragm motors. The power cylinders are fitted with pilot valves. All control valves throughout the plant are fitted with PTFE glands.

Extensive use has been made of multicore copper tubing, mounted on polythene-covered cable trays, for instrument air lines throughout the plant. Alarms operate from tank levels, interface levels, low pressures and gas analyses. Wherever possible, intrinsically safe circuits have been used; elsewhere there are pressurised instrument cases. Level alarms are initiated by float-operated switches, and interface levels by means of conductivity probes.

Experience with the plant, so far, indicates that maintenance is not likely to be a very serious problem and it is expected that the whole of this plant will not require more than an additional two mechanics in the factory's instrument shop.

The total installation cost, including materials, instruments and labour was approximately £75,000.

### Contractors and suppliers

Main contractors for the plant were the A.P.V. Co. Ltd. and Matthew Hall & Co. Other contractors and equipment suppliers included: Babcock & Wilcox Ltd., London Aluminium Co. Ltd., Permutit Co. Ltd., Joshua Hindle & Sons Ltd., Broom & Wade, British LaBour Pump Co. Ltd., British Ceca Co. Ltd., the Power-Gas Corporation and Taylor Controls Ltd.

# GAS CLEANING

## SOME RECENT CONTRIBUTIONS TO BETTER CONTROL OF AIR POLLUTION

# New Approach to Wet Washing of Industrial Gases

**By C. A. Bainbridge**

*(Manager, Dust and Fume Recovery Department, H. Pontifex & Sons Ltd.)*

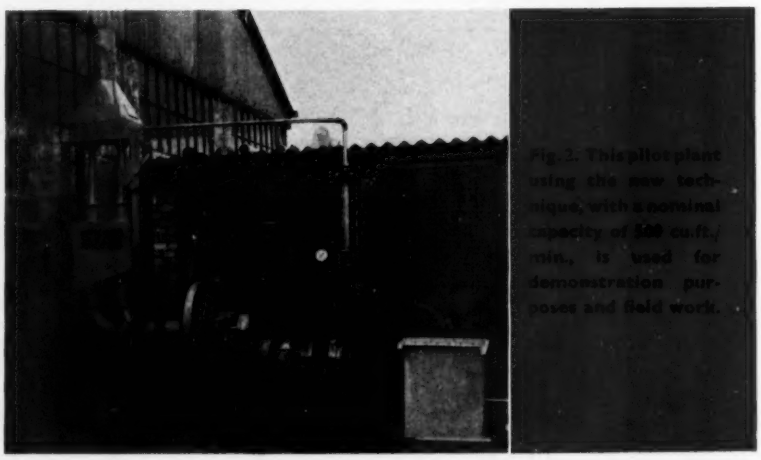
*After a brief discussion of dust and fume recovery problems this article describes a new type of multiple-tube venturi scrubber of interest to the process industries.*

**Fig. 1. How the new scrubber appears when looking downwards into the tube.**

THE introduction of the Clean Air Act and the scheduling of certain industries under the Alkali Act has stimulated a new interest in dust and fume recovery equipment of all types and manufacturers have in many cases found themselves faced with the necessity of dealing with air pollution problems having new and unusual aspects.

Manufacturers of dust and fume recovery equipment have been giving these new problems a great deal of consideration and new types of equipment are continually being developed. The designer of dust and fume recovery equipment has to meet and resolve a number of conflicting requirements, of which the most important are probably efficiency and cost. In many cases the air pollutant is particularly obnoxious and an extremely high recovery efficiency is required, but, at the same time, it is quite worthless and does not bring the user of air pollution equipment any direct economic regain. In these cases the designer has to produce equipment which is capable of the high efficiency required and at the same time the first cost must be realistic and the running costs must not be prohibitive. In his search for a suitable method of cleaning gases and removing the air pollutant the designer has at his disposal only a limited number of physical mechanisms. These are:

(1) Gravitational forces.
(2) The impingement mechanism in which the particle collides with and is retained on a fixed or moving surface.
(3) Centrifugal force as exemplified in the cyclone.
(4) Electrostatic forces where the particle is attracted to a charged surface having a polarity opposed to that of the particle.
(5) Thermal forces which repel the particle and cause it to impinge or settle upon a colder surface.
(6) Impaction—the collision and adsorption of aerosol particles by liquid droplets.
(7) Diffusion—in which case the very small aerosol particles pass



through the gaseous boundary layers of liquid droplets and are absorbed into the liquid particle.

(8) Condensation, in which vapours at temperatures below their dew-points condense readily on nuclei such as aerosol particles which may thereby be agglomerated.

(9) Sonic forces, causing agglomeration of small aerosol particles by sound waves.

These available forces may be used singly or in combination, but the apparatus which is capable of utilising the greatest number of these available forces in combination is almost certainly the venturi-type gas washer, in which the gas and the particles entrained therein are forced into contact with water in the throat of a venturi tube.

Hulse and Strauss[1] have stated that the mechanisms involved in a particular gas-scrubbing process may be some or all of the following: (*a*) impaction, (*b*) diffusion, (*c*) condensation, (*d*) electrostatic charging, and, although the extent to which these mechanisms may be effective in a particular design of plant may be obscure, it is possible that the efficiency which may be achieved can be seriously impaired by the absence of one or more of these mechanisms. The extent to which the processes referred to above occur in the venturi type of scrubber is certainly affected by the particular design and in any case the exact mechanism of the venturi-type scrubber is imperfectly understood. Nevertheless, it is known that, as in several other types of recovery equipment, the smaller the scale, the higher the efficiency which can be obtained, and this has been found to be true in the case of the venturi.

## Multiple-tube venturi scrubber

The search for an improved method of cleaning gases with water has led to the development by the author's company of a multiple-tube venturi scrubber which employs numbers of venturi tubes of small size connected in parallel. In this design, as a general rule, the maximum size of venturi tube is fixed and increased flow rates are dealt with by increasing the number of tubes.

Various methods of providing the necessary intimate contact between the aerosol particles and the water may be adopted, but in the Pontifex scrubber the water is injected into the venturi throats by a high-pressure, solid-cone spray nozzle. The short distance which the water has to travel through the gas stream before reaching the walls of the small venturi throats means that the kinetic energy of the water is substantially maintained across the full path of the gas stream, leading to a considerable increase in target efficiency (see Fig. 1).

The gas and water diffuse through the expanding section of the venturi throats and in this section of the plant it is believed that the mechanism of diffusion and, in the case of hot gases, condensation occurs leading to further recovery of the aerosol particles.

In the Pontifex plant the water is extracted from the gaseous medium by means of a specially designed centrifugal extractor which is fitted to the outlet from each venturi tube. In this device use is made of extremely high centrifugal forces to centrifuge the water droplets out of the gas stream, and it can be readily seen how in their passage across the gas flow further impact between the water droplets and hitherto uncaptured particles can take place.

It is believed that in the Pontifex design use is made of at least four forces—impaction, diffusion, condensation and centrifugal force to capture the particles.

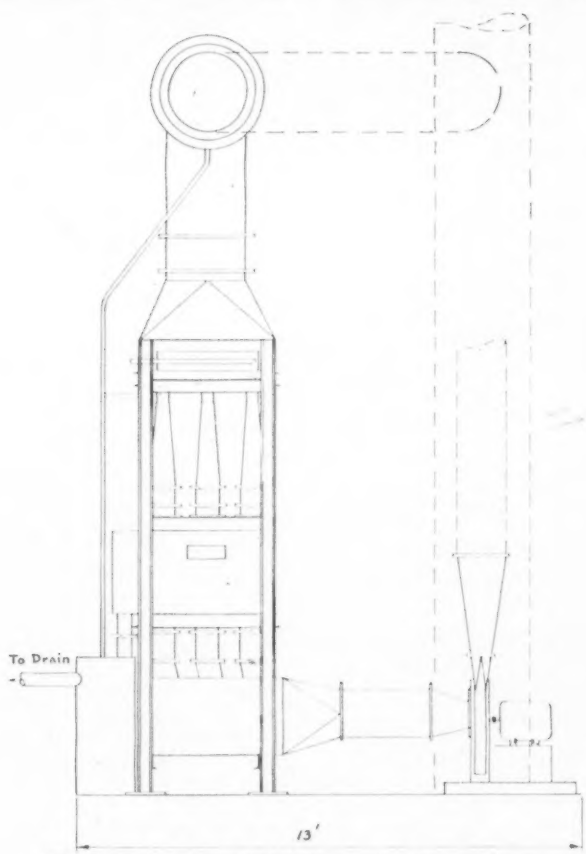



**Fig. 3. Section through Pontifex washer for zinc fume.**

## Pilot-plant tests

Fig. 2 shows a pilot plant, having a nominal capacity of 500 to 800 cu.ft./min. of gas, which has been built for demonstration purposes and to carry out tests on new problems. It will be seen that this plant is fitted with two venturi tubes and is completely portable and self-contained, being fitted with an integral exhaust fan, water circulating pump and instrumentation. A number of tests have been carried out with this plant and Table 1 gives the efficiencies which have been achieved on various problems.

It will be noted from these figures that the water circulating rate is rather higher than has up to now been considered normal for this type of plant,

but in the vast majority of cases this is not of very great moment, as the water is being recirculated and is more than compensated for by the reasonable pressure drops which have a favourable influence on the total fan horse-power. Furthermore, in many cases the considerable drop in gas temperature achieved in the Pontifex design when dealing with hot gases results quite often in a final volume at the exhaust fan of only 50 to 60% of the initial process volume and this factor also has a considerable influence on the fan horse-power.

A continuing programme of tests is being carried out on a wide variety of air pollution problems and a full-scale plant is being installed for dealing with the exhaust fumes from an oil-fire furnace discharging zinc oxide and carbonaceous materials to atmosphere. It will be seen from Fig. 3 that this plant will have six venturi tubes and it is noticeable that the total ground area occupied by the scrubbing unit is only 2 ft. 6 in. square although the total process volume is nearly 6,000 cu.ft./min. at a temperature approaching 500°F. In this installation the gas will be conditioned in a humidifying section before entering the scrubber and the water used for scrubbing will be recirculated.

### Features of new scrubber

In the design of the Pontifex scrubber particular attention has been paid to flexibility and, where circumstances require it, the plant can be arranged horizontally or even inclined at an angle, so that the very real difficulty which sometimes arises of having to install the plant within the limitations of an existing arrangement can be met with the minimum of disruption. The plant is designed for unit construction and may be delivered to site completely assembled in materials and finish to suit particular requirements and, if necessary, a plant can be designed for extension to handle larger volumes of gas than originally specified.

The results of field work with this plant have shown that it is relatively insensitive to fluctuations in gas volume and the recovery efficiency can be maintained within a narrow margin under conditions of varying temperature and gas flow, dust concentration and particle size. It has also been found that a very considerable drop in temperature takes place in the unit, and exit gas temperatures of 26°C. have been achieved with inlet gas temperatures of 150 to 200°C. With these operative conditions the amount of water lost to atmosphere is not serious and in many cases it has been found that the gas is not even fully saturated.

Power and water consumption are naturally higher with this type of equipment than with other types of gas-washing plants using other principles, but in its class the design is capable of giving extremely high efficiencies with economical power ratings.

**Table I. Results of Pilot-plant Tests with Pontifex Scrubber**

| *Process* | *Material* | *Water rate, gal./1,000 c.f.m.* | *Pressure drop, in. w.g.* | *Efficiency, %* |
|---|---|---|---|---|
| Resin coating of paper | Phenol formaldehyde vapour | 16.5 | 19.5 | 100 |
| Exothermic reduction of ores | Silica and various oxide fumes. Ultimate particle size, 1 micron | 14.5 | 12 | 98 |
| Brass smelting | Zinc oxide and carbonaceous materials | 20 | 15 | 99.8 |
| Gas-making | Carbon black. Ultimate particle size, 0.4 micron | 16 | 13 | 90 |

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[1] 'Air Pollution' (Ed., M. W. Thring), p. 214. Butterworths (London), 1957.

## Treatment of gaseous effluent in fertiliser works

Some of the more common methods for treating granulation plant effluents, arising chiefly from dust, fume, noxious or offensive gases, and liquid droplets, were discussed by F. J. Harris at a meeting of the Fertiliser Society in London.

He pointed out that cyclones are almost universally the first method of treatment and will, no doubt, continue to be the means employed for removing over 90% of the dust entrained in the gaseous effluent leaving the drier. During recent years there has been a tendency towards the use of a large number of small-diameter cyclones (1 in. or less), gathered together in a nest, rather than one or perhaps two large cyclones. The advantages of the system are: (a) small-diameter cyclones are theoretically more efficient than large ones, (b) the units are compact, and (c) the pressure drop is usually less with the small ones. The two main disadvantages are: the difficulty of maintaining an even distribution of gas between the individual units and, secondly, the risk of plugging.

Until fairly recent years fabric filters were only used in dust extraction for milling operations and similar duties where the volume of gas to be handled was relatively low, but the recent introduction of the 'reverse-jet' filter has changed the picture. The big improvements associated with this are:

(a) The medium used is a compressed wool felt which itself behaves as a good filter medium and no waiting period is necessary before high efficiencies are obtained.

(b) The dust deposited in the pores of the filter is automatically removed by a reverse jet of air being blown through the fabric from a blow ring encircling the bag and traversing the whole length on a time cycle. The dust so dislodged returns to the gas space inside the bag and eventually falls to the base where it is usually removed *via* the form of rotary air lock and is recovered for reprocessing.

Although not yet well known, the use of irrigated filters provides an attractive approach to the solution of granulation plant effluent problems. In one application a dust-laden gas stream passes vertically downwards through a horizontal bed of metallic wool continuously subjected to co-current washing. Particles are removed from the gas stream by impaction on the fibres and are subsequently washed from the bed by the wash liquid; simplicity, economy of installation, flexibility of design, low pressure drop and high recoveries are quoted as reasons for the use of this system.

After summarising various other methods of dealing with granulation plant effluents, Mr. Harris described

(*Concluded on page* 12)

# Dealing with Noxious Gases

**By W. A. Damon, C.B.E., B.Sc., F.R.I.C., M.I.Chem.E.**
*(Formerly Chief Alkali Inspector, Ministry of Housing and Local Government)*

*The treatment and disposal of noxious gases evolved in chemical processes is an important part of air pollution control. The available methods were summarised by the author at a conference on 'Gas Cleaning in Industry' sponsored by the Norwegian Industries Development Association in Oslo. The following extracts deal with gas cleaning and dust removal methods.*

REMOVAL of grit and dust from waste gases may be effected by (i) baffles and settlement chambers, (ii) cyclonic devices, (iii) wet scrubbers, (iv) fabric filters, (v) electrical precipitation or (vi) a combination of the foregoing.[1]

Baffles and settlement chambers are adequate only for the separation of relatively coarse particles, exceeding (say) 150 microns. Cyclones have been developed to a high degree of efficiency. Designs are available which will effectively separate particles down to (say) 20 microns but these involve a substantial pressure drop which increases the cost of operation. Simple wet washers are relatively cheap but do not arrest fine particles. The high velocity venturi scrubber, on the other hand, is efficient down to sizes of 1 micron but is expensive in both capital outlay and running costs as it requires a pressure drop of about 25 in. water gauge. Wet washers require a supply of clean water and the disposal of liquid effluent may present difficulties. The escapes, moreover, are loaded with water vapour and are often undesirably conspicuous.

Fabric filters are probably the most highly efficient means of trapping fine dusts. There are two kinds: (a) the frame type which has to be periodically shaken and (b) the reverse jet which requires less filtering area for a given volume of gas. The installations are expensive as also are operating costs. Electrical precipitators when operating properly are equally or very nearly as efficient as fabric filters and they involve only a low pressure drop. The capital cost of installations is, however, very high.

The matter of dusty emissions from cement-making processes has received special attention.[2] The effluent gases from wet rotary cement kilns amount to about 140,000 cu. ft. (N.T.P.) per ton of clinker produced and kiln outputs are up to 35 tons of clinker/hr., depending on the diameter and length. The dust burden of the waste gases varies widely according to the nature of the raw materials used and the kiln design. An intensive system of chains is usually fitted in the feed end. The purpose originally was to conserve fuel by recovering a greater proportion of the sensible heat contained in the gases but the system also results in a substantial arrestment of duct. Nevertheless, further means are usually necessary and electrical precipitators are in fact provided at all the larger British cement works. They require skilled maintenance and are expensive to install; a precipitator to match a medium to large sized kiln costs about £100,000. At certain smaller factories, high-efficiency cyclones have been found adequate. Dust arises also from the grinding of clinker and the bagging of cement. These emissions are usually dealt with by fabric filters.

## Noxious gases

The more common noxious gases arising in chemical processes are:

**Sulphur dioxide.** Since the development of muffle-type calciners, rapid progress has been made so that all the sulphur dioxide arising in the production of zinc from zinc blend in England and Wales is now usefully employed in the production of some 150,000 tons p.a. of sulphuric acid. Except at zinc smelters, operations involving the smelting of sulphide ores are on a relatively small scale and are connected with the production of copper, lead, nickel, antimony, tin and molybdenum. Several processes for the recovery of sulphur have been investigated but a minimum sulphur dioxide content of 0.5% in the waste gas is necessary for economic recovery and the average in Great Britain is about 0.1%. There are certain operations such as the blowing of copper converters where short-term peak concentrations of about 1% may be attained and, where there are a sufficient number of such converters, it is possible, by staggering their operation, to secure a continuous stream of gas of fairly uniform composition and sufficient high concentration to justify treatment. The scheme is, however, not applicable in Britain.

Escapes of sulphur dioxide from the exits of sulphuric acid plants depend on the efficiency with which the process is conducted and one grain of $SO_2$ per cu. ft. represents roughly 1% loss of efficiency. In chamber plants, by careful regulation of the conditions in a correctly designed plant, it is possible to secure escapes consistently below 1.5 grains/cu. ft. Similarly in four-stage contact plants burning brimstone, the escape should not exceed the equivalent of 2% of the sulphur burned. In the anhydrite process, it may not be possible to attain this standard and recourse to scrubbing the exit gas with either soda or ammonia may be necessary.

The removal of sulphur dioxide from waste-fuel gases can be effected by scrubbing with ample volumes of slightly alkaline water. This subject and the development of better methods is dealt with in a recent paper by Rees.[3] Scrubbing with milk of lime is practised at a number of works where small volumes of waste gas containing relatively high concentrations of sulphur dioxide are produced. Sulphur dioxide arising from the roasting of copperas, as in the production of iron oxides, is normally absorbed by passage through towers packed with limestone or scrap iron and irrigated with water.

Absorption of sulphur dioxide in water to produce acid of useful strength has also been attempted in connection with the recovery of waste pickle liquors used in the iron and steel industry.[4]

**Hydrogen chloride** being exceptionally soluble in water, there is little difficulty in removing it from waste gases. By arranging a countercurrent series of absorbers, hydrogen chloride produced for example in organic chlorinations may be recovered at a useful strength. A final clean-up can be effected by the use of a wash tower, the effluent from which is run to waste.

**Hydrogen sulphide.** Waste gases containing hydrogen sulphide may be scrubbed with caustic soda to produce sodium sulphide or the hydrogen sulphide may be absorbed by passage through hydrated iron oxide which can be regenerated to produce spent oxide containing up to about 50% of sulphur. There are other liquid purification processes which are suitable when quantitative removal of the hydrogen sulphide content is not essential. Where the amount of hydrogen sulphide is sufficient to justify the capital outlay (as at large petroleum refineries) it becomes practicable to strip it out by means of a solvent, such as diothanolamine, and to regenerate it in concentrated form for treatment in a Claus kiln with the production of pure elemental sulphur. In other cases, for example, at sulphate of ammonia plants associated with a sulphuric acid plant, the waste gases containing hydrogen sulphide may be burnt to sulphur dioxide for conversion to sulphuric acid. In exceptional circumstances, it may even be permissible to discharge the resultant sulphur dioxide to atmosphere through a suitable chimney.

**Chlorine.** Gases containing chlorine may be purified by scrubbing with an alkaline solution or by contact with milk of lime to produce the corresponding hypochlorite. Passage through a tower packed with scrap iron and irrigated with water is also reasonably effective. These methods are particularly applicable to gases containing low concentrations of chlorine. ' Snift gas ' is a term used to describe the gases vented from, *e.g.*, the liquefaction unit of a chlorine plant. Such may contain 20% of chlorine and its disposal presents a more serious problem. A method has been developed whereby the chlorine content is absorbed in carbon tetrachloride and then released by stripping at a concentration which allows it to be recovered as a liquid.[5]

**Oxides of nitrogen.** Nitrogen peroxide may be recovered in the form of nitric acid by water washing but for every three molecules of nitrogen peroxide thus absorbed there is evolution of one molecule of nitric oxide which must be re-oxidised to nitrogen peroxide in order to complete the cycle. Total absorption is therefore not possible, and as the oxidation of NO to $NO_2$ becomes progressively slower as the concentration of the former is reduced, it is clear that a point must be reached beyond which plant would be required of such size as to make it impracticable. Gases from ammonia oxidation plants can however be denuded of their oxides of nitrogen content to the extent of about 98%. Gases from the dissolution of metals in nitric acid can be similarly dealt with and efficiency can be increased by addition of oxygen. Small quantities of oxides of nitrogen can be destroyed by admixture with coal gas and burning.

In sulphuric acid chamber plants, oxides of nitrogen are recovered by absorption in well-cooled sulphuric acid of 78 to 80% strength. Conditions should be so regulated that the oxides of nitrogen presented to the Gay Lussac towers are substantially in the form of $N_2O_3$. The temperature of the absorbing acid should be not greater than 30°C.

**Fluorine.** Outbreaks of fluorosis in cattle have generally occurred in the vicinity of industrial undertakings using raw materials which would make discharges of fluorine compounds likely. In an aluminium works where this metal is produced by the electrolysis of a solution of bauxite in aluminium fluoride this problem led to the installation of new furnaces from which the fume is extracted with as little excess air as possible. Thus the volume of fume is reduced to manageable dimensions for treatment by alkaline washing followed by electrical precipitation. Some 95% of the alkali-soluble fluorine compounds in the fume is now arrested.

Brick-making from certain kinds of clays and the smelting of ironstones are processes from which fluorine may be evolved in small quantities. Similar problems have also arisen in connection with the use of fluorspar as a flux in steel-melting processes. It is obviously possible to scrub hydrogen fluoride out of waste gases but the volume and temperature of gas to be treated would make the undertaking a formidable one. Moreover, as in the case of sulphur dioxide in flue gases, the advantages gained by removal of the noxious constituents are offset to some extent, by the cooling of the waste gases.

In the production of superphosphate, up to half of the fluorine contained in the raw rock is evolved in the form of silicon tetrafluoride. Fans are provided to draught the mixers and dens into a series of void towers, in which the gases are washed by liberal spraying with water. The tetrafluoride is thereby decomposed with the release of silica and hydrofluosilicic acid which is removed in the waste water. With care and the provision of adequate tower space, the removal of over 99% of the acid constituents can be effected. Fluorosis outbreaks in Britain do not seem to be in any way connected with these works.

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[4] W. Bullough, Iron and Steel Inst. meeting on Water Pollution, London, December 12, 1957.
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## Treatment of gaseous effluent in fertiliser works

(*Concluded from page* 10)

some experiences of his company, Scottish Agricultural Industries Ltd., in the use of a venturi scrubber as a means of handling gaseous effluent from the drier at the Ayr plant. The most novel feature of this unit is the length and narrowness of the throat. The height is only 5.6 in. and this feature is considered very important if good water coverage is to be ensured. The long throat was used since the pilot-scale tests had indicated that it gave higher collection efficiency than the conventional short throat. In it, droplets leaving the sprays are accelerated to approximately the velocity of the gas stream, and the improved performance is believed to be due to the increased period during which the gaseous effluent and water droplets are exposed to the maximum degree of turbulence, and, in addition, some measure of double effect is obtained. At the entrance to the throat the water droplets are at zero velocity relative to the solid particles in the gas stream, so that the gas-borne particles impinge on the droplets, while at the exit from the throat the water droplets decelerate more slowly than the gas-borne solid particles and the water droplets then impinge on the solids.

Probably the most unusual features are the serrated skirt and the coned exit which it surrounds. The purpose of this skirt is to minimise carry-over of particulate water. From the cyclones (a nest of four, each approximately 13 in. long by 3½ in. diameter), the gas passes *via* a single-stage, high-efficiency fan to the chimney.

# Gas Cleaning Developments in Brief

## Washer-precipitator copes with difficult particles

Where air or gases to be exhausted from a system carry a burden of noxious or potentially dangerous matter, this material often declines to obey fundamental laws whereby comparatively simple arrangements could be made to prevent its escape to atmosphere or another section of the plant. Ammonium chloride, for instance, with a solubility of 29.4 parts in 100 parts of water at 0°C. cannot be satisfactorily arrested by a scrubber, even when in the form of a fume with particle sizes of less than 2 microns.

Usually this type of problem involves large quantities of air or carrier gas, with a very light burden of particulate matter, and herein lies one of the principal difficulties in treatment by conventional apparatus, for the phenomenon of mass attraction which is most effective with heavy 'dust burdens,' is practically non-existent with very light burdens. Collection or arresting light-burdens therefore depends almost entirely upon the functions of the apparatus being employed.

The new Sturtevant washer-precipitator is claimed to be successful in this direction. Efficiency of collection up to 99.9% is being obtained on materials such as ammonium chloride, nitric acid, hydrochloric acid, sulphuric acid, sodium carbonate, sodium bicarbonate, sodium sulphate, sodium phosphate, and sulphate fumes from fertiliser plants.

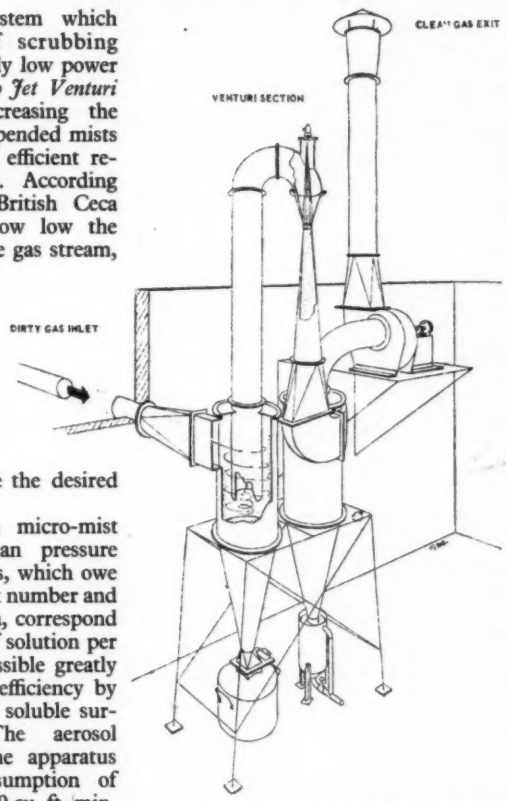
The makers are not revealing any technical details at present but they say it is economical to run and is highly efficient, being able to arrest all particle sizes, including those in the sub-micron range. The whole plant is built of corrosion-resistant materials and water and power requirements are extremely low.

## High-velocity impact gas scrubber

A wet scrubbing system which combines economy of scrubbing liquors with comparatively low power requirements is the *Aero Jet Venturi RB*, a device for increasing the average size of finely-suspended mists or dusts to enable their efficient removal by classic methods. According to the manufacturers, British Ceca Co. Ltd., no matter how low the content of particles in the gas stream, the apparatus operates efficiently as the aerosol produced can be adjusted to give the optimum density and size-distribution. In many cases existing cyclones and filters hitherto operating with low efficiency can be re-utilised to give the desired result.

The generation of a micro-mist requires less liquid than pressure atomising; the fine drops, which owe their activity to their great number and their high superficial area, correspond to a very small volume of solution per unit time. It is also possible greatly to increase the collision efficiency by using small quantities of soluble surface-active agents. The aerosol generators used with the apparatus have a maximum consumption of compressed air of about 50 cu. ft./min. free air.

All the liquid injected is effective, and since there is no sheet of liquid to be pulverised by the gas stream, the loss of head across the venturi is at a minimum. This factor is important where large volumes of gas are being dealt with. The total power requirements are usually of the order of 1.7 h.p./600 cu. ft./min. of gas treated.




**Layout of a typical 'Aero Jet Venturi' installation.**

## Silica fume and electrostatic precipitators

In the production of ferrosilicon in an electric arc furnace, the collection of silica fume presents a problem. A recent study in the U.S.A. indicates the feasibility of collecting silica fume at high efficiencies in either a dry- or wet-collection electrode precipitator installation. The objects of this study were to determine the weight efficiency of fume collection and to make an estimate of the economics of electrostatic precipitation as applied to silica-fume collection.

The pilot electrostatic precipitator consisted of a single, vertical collection electrode in the form of a tube of 6-in. i.d. and 9 ft. long. Suspended in the centre of the collection electrode was a single discharge wire $\frac{5}{32}$ in. square energised from an 8 kva. vacuum-tube power pack. The unit was equipped with spray nozzles to allow wetted-wall operation.

Briefly described, the operation of the electrostatic precipitator involved energisation of the discharge wire with a negative high voltage sufficient for corona discharge. The furnace gas molecules near the vicinity of the discharge wire were dissociated into positive and negative ions under the action of the corona discharge. The negative ions, in being repelled from the negatively charged discharge wire, contacted fume particles and imparted charges to them. These negatively charged fume particles migrated to the grounded collection electrode and deposited there. The collected particles were either dislodged from the collection electrode by rapping the outer walls of the electrode or washed off by the descending water stream during wetted-wall operation.

Six runs were made while operating the electrostatic precipitator with dry silica-fume-containing furnace gases

and an additional two runs were made with furnace gases treated with steam. The electrical operation of the precipitator during these runs was poor, as is characteristic of high-resistivity dust precipitations.

However, although silica fume is apparently a high-resistivity dust, collection efficiencies in excess of 97% were obtained while operating the precipitator on dry untreated fume. These efficiencies may be somewhat misleading in that they probably represent time-dependent average collection efficiencies. Electrical operation becomes rougher during the course of a run and it would have been impossible to maintain corona discharge for much more than the 75 min. maximum running time tried. For commercial design it would be necessary either to provide an adequate rapping system for dislodging the collected fume or periodically to wash the fume off the electrode.

The electrical operation of the precipitator during wet-collection electrode run was stable and collection efficiencies in excess of 92% were achieved.

Capital investment costs and operating expenses for a silica-fume electrostatic precipitator were estimated. The estimated capital investment of $2.63/cu. ft./min. is high for a high-energy scrubbing device. Operating expenses on the other hand are lower than those necessary for operating a suitable scrubber. These cost estimates indicate that it would cost over $200,000 for a unit to handle all of the gases from a single 5,000-kw. electric furnace. These costs would be extremely high for the small ferro-silicon manufacturer and indicates the need for drastic reduction of the volume of furnace gases by suitable hooding and enclosure.

The study was part of a programme carried out by the Fuels and Air Pollution Division of the Battelle Memorial Institute, and the results were given in a paper presented to a meeting of the Air Pollution Control Association in San Franciso by J. E. Yocom and S. Chapman.

## Oxide purification in the gas industry

The gas industry has had long experience of the removal of hydrogen sulphide from town gas by iron oxide. Conventional box, tower and tower box purifiers have retained the practice of using oxide preparations of either synthetic or natural origin. Mr. A. C. Bureau, B.SC., M.INST.GAS E., F.INST. PET. (director, George Scott & Son (London) Ltd., and gas consultant to Henry Balfour & Co. Ltd.), points out that recent development trends in the fields of pressure gasification and the desirability of removing organic sulphur compounds have necessitated attention being given to modification and alternatives.

Higher pressures and lower hydrogen sulphide contents have evolved towers of smaller cross section and thicker plate fabrication with its accompanying stringent requirements, highly mechanised oxide handling and simplified gas connection arrangements to facilitate ease and frequency of rotation. Design features catering for variations in hydrogen sulphide loading have been embodied and steps taken to minimise local high temperatures. Condensate discharge, purging and isolation have each required careful consideration with the adoption of some ingenious new methods.

Until recently organic sulphur removal necessitated additional plant involving catalytic conversion to hydrogen sulphide, followed by further oxide catch boxes, but the newly developed Frodingham Desulphurising Process employing the modern technique of fluidisation of a special oxide marks a revolutionary advance, Mr. Bureau says. In this process both hydrogen sulphide and organic sulphur are simultaneously removed and the sulphur can be recovered as sulphuric acid of great purity and in strengths up to 98%.

### To Authors of Technical Articles and Books

*The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to* The Editor, CHEMICAL & PROCESS ENGINEERING, Leonard Hill House, Eden Street, London, N.W.1.

*In addition, the Publishers and Editors of the Leonard Hill Technical Group are always ready to consider technical and scientific manuscripts with a view to publication. Correspondence should be addressed in the first instance to the Book Production Manager, at the above address.*

## BRITISH STANDARDS

**Acid-resisting piping** (B.S. 1333: 1958, 6s., ' Acid-resisting silicon iron pipes and pipe fittings,' 22 pp., illus.). This revised publication deals with three types of pipes and pipe fittings: cone ended, spigot and socket, and plain ended. The size range is 1 to 12 in. nominal bore. The main differences between this and the first (1946) edition are (*a*) there are now requirements for loose coupling flanges and (*b*) requirements for the 2½-in. and 5-in. sizes have been omitted.

The body of the specification contains clauses on material, workmanship, finish, testing and marking and (for the flanges) drilling, and bolts and nuts. An appendix to the publication lists information which a purchaser should provide when submitting an enquiry or order; another contains a recommended method for coupling plain pipes.

**Stainless-steel tubes** (B.S. 3014: 1958, 4s. 6d., ' "As welded " and cold-drawn welded austenitic stainless-steel tubes for mechanical, structural and general engineering purposes '). Requirements are specified for tubes of this description which are manufactured from strip welded across the abutting edges throughout their length. Tubes in the ' as welded ' condition are available in sizes from ⅜ to 2¼ in. outside diam. (in ⅛-in. steps) and in thicknesses from 22 to 12 s.w.g., depending on the diameter.

**Safety colours.** An amendment to B.S. 2929: 1957, ' Safety colours for use in industry,' recognises that use of a green cross to indicate first-aid goods and equipment might possibly be considered as an infringement of certain registered trade marks. To avoid any risk of confusion the standard will now recommend that location of first-aid equipment should be indicated by the use of the works ' First Aid ' printed in bold white capital letters on a green rectangular background.

**Methods of testing plastics** (B.S. 2782: 1958, 10s. Part 5, Miscellaneous methods, 46 pp., illus.). This new publication marks another step towards the fulfilment of B.S.I.'s intention to issue in one standard the methods of test currently used by the plastics industry. Properties dealt with include: apparent density and bulk factor, water absorption and water-soluble matter, boiling water absorption, water vapour absorption, resistance to chemicals, colour bleeding, colour fastness to light, flammability and density.

# Chemical Engineering Data Book

## NEW HANDBOOK FOR THE 'HIDDEN MEN' OF THE PROCESS INDUSTRIES

'IN common with other technologies, chemical engineering has made extensive strides during recent years. Theories underlying the unit processes and operation of the production industries have been subject to searching practical tests and a considerable amount of experimental data has been published relating to plant design and operation. Owing to the wide range of industries served by the chemical engineer, however, much of this information is widely scattered in the literature and is not easily accessible.

' It is for this reason that a " Chemical Engineering Data Book " should prove of great value both to students of the subject and to practising chemical engineers. The scope of the work is almost sufficient to justify its inclusion amongst textbooks of chemical engineering; but in addition an immense amount of fundamental data is given in tabular form and numerous examples are worked out showing how the data can be applied to practical problems.'

This comment by Prof. D. M. Newitt, M.C., F.R.S., appears in a foreword to ' Chemical Engineering Data Book ' and he goes on to compliment the authors, Dr. D. C. Freshwater, PH.D., M.SC., M.I.CHEM.E., A.M.INST.P., and Dr. T. K. Ross, PH.D., A.M.I. CHEM.E., on the way in which they have ' performed the difficult task of compressing this large amount of material into a reasonable compass without loss of clarity. They have kept in mind the requirements of the practising chemical engineer and have endeavoured to place at his disposal the latest data relating to design and operation together with sufficient background information on the more theoretical aspects of his subject to enable him to check his calculations.'

The book is a welcome revival of that familiar compendium of information previously known as ' Chemical Industries,' the 24th edition of which it incorporates. One of the virtues of the work in its previous form was that it provided a basis of theoretical knowledge, combined with practical detail which was invaluable to the chemist or engineer engaged in the chemical industries, in the period when the output of trained chemical engineers was very small indeed.

As the authors of the new book point out, the situation today is radically different from what it was when ' Chemical Industries ' first appeared —chemical engineering is a recognised profession and prodigious efforts are being made to fill the truly enormous gap in its ranks. There are countless ' hidden men ' in the process industries who at present fill this gap by discharging the functions of the chemical engineer, although their initial training was in chemistry or engineering. It is to these men that this revised form of chemical industries, under its new title of ' Chemical Engineering Data Book,' is directed and dedicated.

The book comprises four main sections. First, there is a section covering general engineering as it affects the chemical engineer, which includes chapters on economics and costing, fuels and power generation, refrigeration, engineering in the chemical works, and materials of construction.

The next section deals with conventional unit operations of chemical engineering. Each chapter has a descriptive section followed by the more useful and important quantitative relationships for the solution of problems, together with worked examples.

In the third section, the principles outlined in the first two sections are illustrated by actual examples. After a chapter on process evaluation, the reader is able to follow the working through of complete designs of (*a*) a causticising plant, (*b*) an acetone recovery process and (*c*) a plant to produce 1,500 tons p.a. of ethyl acetate. These examples are well chosen, the processes being well established and illustrative not of any particular novelty of manufacture but rather of the general method of attack. This section of the book, with its pull-out flowsheets and its wealth of graphical and tabulated data, is alone a valuable addition to the literature of practical chemical engineering.

The fourth section of the book comprises extensive tables of physicochemical, mathematical, and other useful data. Finally there are sets of commercial indices listing manufacturers of equipment and chemicals covering the whole range of products of chemical industry and process plant fabrication.

' Chemical Engineering Data Book ' will undoubtedly fulfil the need for a new and comprehensive guide to chemical engineering problems, while its new format and easy-to-handle size make it admirably suited to fill the present gap in the chemical engineering bookshelf. Copies of this illustrated book, which contains 1,200 pages, can be obtained, price 84s. net, from Leonard Hill (Books) Ltd., Leonard Hill House, Eden Street, London, N.W.1.

**At a reception held recently to launch ' Chemical Engineering Data Book ' Mr. W. Leonard Hill (*left*), chairman of the publishing company, discusses the book with the authors, Dr. T. K. Ross (*centre*) and Dr. D. C. Freshwater.**

# Cutting the Cost of Heavy Water

**By M. C. Reece, B.Sc., Ph.D.**

*A British company recently announced details of a new process for heavy water which, it was claimed, would produce this material at a price below the American figure of $28/lb. Other new processes and modifications to existing plant were described in papers presented at the Geneva conference on the peaceful uses of atomic energy. Here some new heavy-water processes, proposed or actually in operation, are discussed.*

HEAVY water is an excellent moderator which can be used to make a small and compact reactor fuelled with natural uranium. Because of its nuclear properties it is used in many countries, but established processes are very costly and only a few nations can afford to manufacture it themselves. With the cheap electric power available in America and the huge plants erected there, it was possible to make heavy water available at a price low enough to make production uneconomic in many other countries.

However, some countries, like India, prefer to be independent of outside sources and are erecting plants which, when built together with processes that use the by-products, make the heavy water at a price not greatly above the American figure. As processes are developed it is possible that many countries, including Britain, will set up their own manufacturing plant.

Constructors John Brown Ltd., of Britain, have developed a process which, they claim, can be operated economically on a relatively small scale when the plant is operated in conjunction with an ammonia synthesis plant. It is based on a combination of ammonia-hydrogen exchange and ammonia distillation. The extraction of deuterium from ammonia synthesis gas and the first stage of concentration to 23 times the natural, are accomplished by flowing, countercurrently, hydrogen, contained in ammonia synthesis gas, and liquid ammonia containing a potassium amide catalyst. Further concentration, up to 75% deuterium/hydrogen is by ammonia distillation, while the final purification is a water distillation in a Kuhn-type column.

Chemical engineering flowsheets are given in Figs. 1 and 2, which show the two main sections of the plant. In the exchange section, Fig. 1, ammonia synthesis gas at 255 atm. pressure is cooled from ambient temperature to –36°C. in heat exchanger H.E.1, and then to –40°C. in a further refrigerated unit. In the recovery tower E.1 the gas is scrubbed with liquid ammonia containing potassium amide in solution, 70% of the deuterium in the gas is removed and transferred into the liquid ammonia phase. The gas leaves the tower, passes through H.E.1 to cool the incoming gas, and then goes back to the ammonia synthesis plant. The only difference from this point of view is that the gases now contain ammonia vapour.

The liquid ammonia leaving tower E.1, at a deuterium concentration of five times natural, is pumped to the top of cold tower E.2 where it flows countercurrently to a mixed gas stream circulated continuously between towers E.2 and E.3.

### Concentration changes

The concentration of deuterium in the ammonia is increased to 23 times natural by the circulating gas and the gas concentration, which is initially five times natural, is thereby reduced to 0.6.

The liquid ammonia emerging from the tower E.2 at –40°C. is warmed to –14°C. in H.E.3, and expanded in two stages from 250 atm. down to the

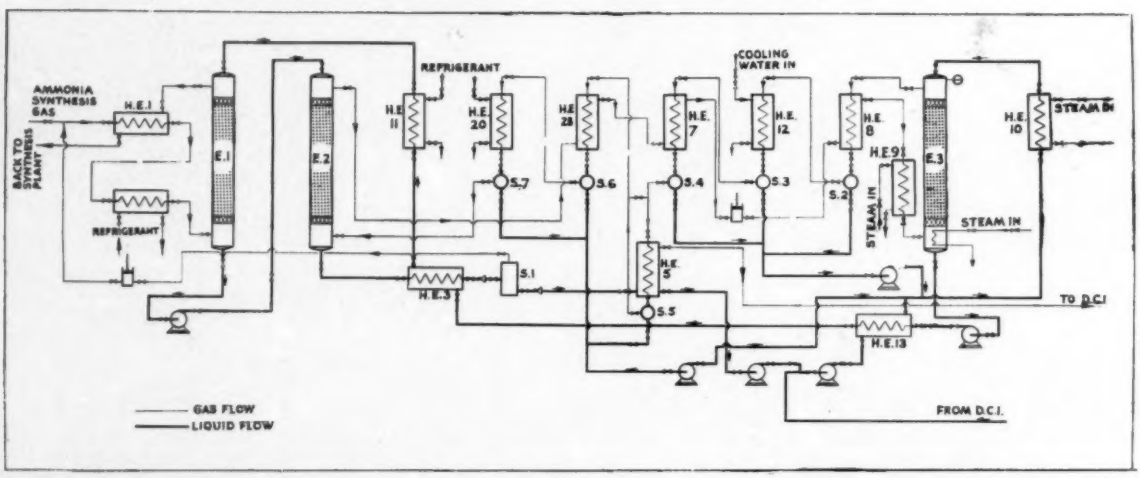



**Fig. 1. In the exchange section of this heavy-water plant deuterium is stripped from ammonia synthesis gas by liquid ammonia.**

ordinary pressure. Dissolved mixed gas which is liberated after the first stage of expansion (to 3 atm.) is separated in S.1 and recompressed to be returned to E.1.

The liquid ammonia is fed to evaporator H.E.5 where half is evaporated and sent to distillation column D.C.1. The remainder of the liquid ammonia, carrying the whole of the catalyst in solution, joins the returning lean stream of liquid ammonia from the top of D.C.1. The combined stream, which equals the volume originally fed to the vaporiser, is pumped to 250 atm. and warmed to 93°C. in heat exchanger H.E.13, after which it is joined by streams of ammonia condensed from the hot mixed gas stream leaving tower E.3 from the various traps, and is raised to 100°C. in steam heater H.E.10. Passing into hot tower E.3 it meets in countercurrent the circulating mixed gas.

The deuterium content of the ammonia stream, now reduced to 20 times natural, is transferred to the circulating mixed gas and the ammonia concentration is reduced to three times natural. The hot ammonia leaving the tower is passed through H.E.13 and H.E.3, which cool it to –36°C. The refrigerated H.E.11 completes the cooling to –40°C. and the circulating ammonia is passed into the recovery tower E.1.

The circulating mixed gas stream leaving the cold tower E.2 is successively warmed in H.E.28 and H.E.7 to approximately room temperature. It is then further warmed by H.E.8 and the steam heater H.E.9. The gas at 100°C. is passed to the hot tower E.3 in the base of which steam coils ensure its saturation with ammonia vapour. The mixed gas leaving the hot tower is cooled in H.E.8 and separated liquid ammonia is removed in S.2. It rejects further heat to cooling water in H.E.12, more separated liquid ammonia is removed in S.3, and it is further cooled in H.E.7 followed by the separator S.4.

## Cooling the mixed gas

The mixed gas then passes through the evaporation coils in H.E.5 with separation from ammonia in S.5, and finally cooled in H.E.28 and the refrigerated H.E.20.

The circulating mixed gas now at –40°C. is passed into the cold tower E.2.

Nine columns form the distillation section (Fig. 2), the first seven of which are in cascade. Ammonia vapour from H.E.5 is fed into column D.C.1 at 3,215 kg./hr., the boil-up rate being 45,500 kg./hr. Five of the columns are equipped with re-boilers and there is a vapour compressor between each pair of columns.

## Vapour supplies heat

The saturated vapour leaving the top of D.C.1 is compressed to 40 p.s.i.a. at 36°C. and serves as heating medium in the re-boilers R.1, R.2, R.3, R.4, and R.5. Part of the compressed vapour passes to the refrigeration plant whereby heat in-leak and the heat generated by vapour compression is removed from the system. The liquid condensing in the re-boilers is collected in a common main and pumped to the top of column D.C.1, at which point the reject from the column system is returned to the exchange section. The liquid leaving the base of D.C.1 divides into two streams, 20,500 kg./hr. being pumped to the head of D.C.2 while the remainder is evaporated in the re-boiler R.1. Similar arrangements apply at the base of D.C.2, D.C.3, and D.C.4. The vapour leaving the top of D.C.2 is recompressed from 16 to 20 p.s.i.a., similarly between the other columns, maintaining the entire distillation train near atmospheric pressure. Each column contains the equivalent of 40 theoretical plates, this arrangement having been selected as the height of column requiring minimum capital expenditure; the distillation towers are 130 ft. high.

At each transition the column diameter decreases corresponding to the enrichment achieved. At the degree of concentration reached at the base of D.C.4 (12.8%) further economies obtained by reductions in column diameter are very small and therefore columns D.C.5, D.C.6, and D.C.7 are operated at the same reflux rate. Practically the whole of the liquid reaching the base of D.C.7 is evaporated in re-boiler R.5, but a small proportion is withdrawn and mixed with a stream of fresh water. The water withdrawn from the top of the Kuhn column also joins this stream before passing to column D.C.8 where the ammonia and water are separated after establishing exchange equilibrium. Pure ammonia from the top of D.C.8 is compressed and condensed, part of this condensed ammonia being returned to D.C.8 as reflux and part returned to D.C.7. The water is pumped to the Kuhn column which separates it into pure heavy water (99.8%) and a reject fraction at 40% $D_2O$ concentration which is returned to column D.C.8.

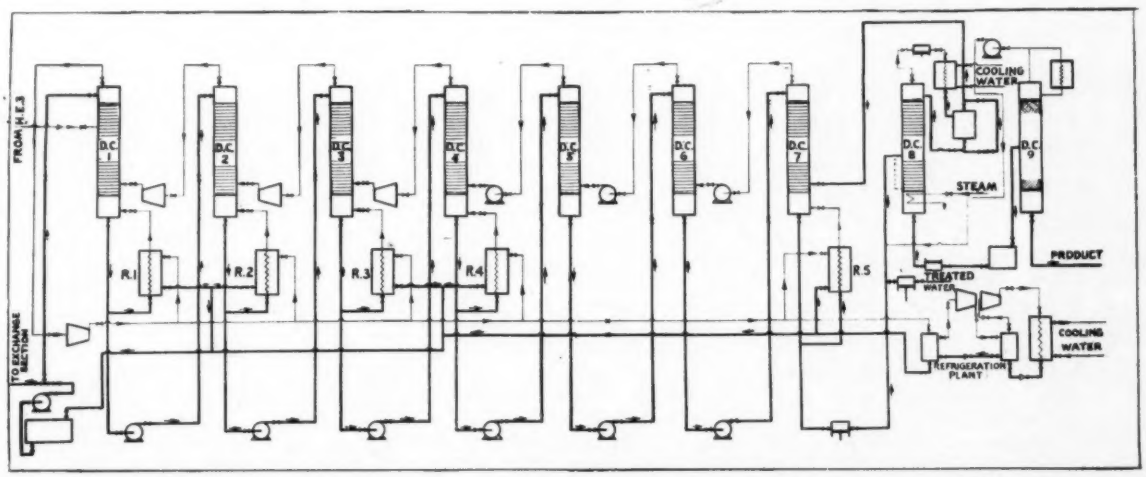



**Fig. 2. The distillation section consists of seven columns in cascade, followed by a separating column and a Kuhn distillation unit.**

### Column packing

Mild steel suitable for service at -33°C. is the material of construction. The columns are packed with *Spray-pak*, specially developed at Harwell for heavy-water distillation. Standard refrigeration compressors are used with water seals which prevent ammonia leakage.

The plant is designed to handle 20 tonnes/hr. ammonia synthesis gas containing 75% hydrogen at synthesis pressure. This is returned to the ammonia plant at 250 atm. Thirty tonnes of liquid ammonia makes up the first charge with 50 kg./hr. make-up. An initial charge of 300 kg. of potassium metal is needed for the catalyst and the make-up rate is 1 tonne p.a.

Removing 70% of the deuterium from normal hydrogen gas the yield is 3.5 kg./hr. or, on an 8,000-hr. year, some 28 tonnes p.a.

Capital costs, which vary with the location, are of the order of £80,000 per tonne production p.a. This figure is said to be lower than other plants for heavy-water production.

Operating costs are approximately £4 to £5 per kg. and allowing 15% as the interest on capital and plant depreciation this gives a cost, of heavy water produced, of $21.5/lb.

### American plants

Three processes in series are used to extract heavy water from natural water at the Savannah River plant, U.S.A. (refer to Geneva conference paper 1065). Preliminary concentration up to 15% is carried out by a dual temperature exchange between hydrogen sulphide and water. From there the water is distilled *in vacuo* to make the concentration up to 90% and finally electrolysis is used to produce a final concentration of 99.75% or better.

The dual temperature hydrogen sulphide process is covered by U.S. Pat. 2,787,526 but further details are prohibited under a court injunction. In this dual temperature exchange the driving force is the ratio of separation factors at the two temperatures and in practice the ratio ranges from 1.1 to 1.4.

Vacuum distillation gives a separation factor of only 1.05 at 100 mm. Hg abs. and is the chief drawback to this method.

Much more favourable is the separation factor for the electrolytic process —a practical figure is approximately 8 —but it is essentially a discontinuous process in that the water has to be electrolysed and then recombined each time. For this reason it was used to concentrate mixtures already containing a substantial percentage of heavy water.

The distillation plant at Savannah River is designed to use a feed containing 10% $D_2O$ and separate this, through a series of six columns in cascade, to give an overhead fraction containing 3% and a bottoms product of 98% $D_2O$. The light fraction is returned to the hydrogen sulphide-water exchange sections.

Each distillation column is of conventional bubble-tray design. There are 72 plates in all but one column and they decrease in diameter, the first being 90 in., the second 68 in., the third 60 in. and the last three 48 in. diameter. The trays contain 4-in. bubble caps set on 12-in. centres and have an estimated efficiency of 70%. Over a 72-plate column the pressure drop is 220 mm. Hg.

The electrolysis plant is made up of 150 cells each having a carbon steel cylinder, 12 in. diam., that functions as the cathode, while a smaller concentric nickel insert acts as the anode. Water cooling keeps the cell at 25°C. and the mixed gas coming off is cooled to 5°C. to condense out the water vapour. The gas mixture is then burnt to recombine the elements, the vapour condensed as 'overhead product.'

### Electrolysis processing

In operation the product from the distillation section is treated with potassium permanganate, followed by evaporation, to remove traces of organic impurity like lubricating oil. Then 100 lb. is mixed with 8 lb. of potassium carbonate and placed in each cell. If the charge contains 90% heavy water some 50 lb. of water is electrolysed to leave a residue of 99.75% or better. This is evaporated to remove the potassium carbonate which is reused.

Over $164 million was spent on the Savannah River plant, of which $2.5 million represents the cost of the distillation plant and some $1.5 million the electrolytic units. At a maximum production rate of 1 million lb. p.a. the 'investment per annual pound' works out at $164. Operating costs work out at $14/lb.

Research work is being carried out in America to develop the hydrogen distillation process using ammonia synthesis gas as feed. The main advances suggested (conference paper 1063) are in the use of recently developed techniques for insulation. In a pilot plant, reversing heat exchangers have been used for removing nitrogen, below its triple point, from the hydrogen feed stream.

Results indicate an increase in the economic advantage of using low-temperature heavy-water processes over others investigated. The reversing heat-exchanger experiment confirmed analytical predictions which suggested that complete nitrogen removal requires solid condensate filtering to avoid fouling by solid nitrogen in the extreme low-temperature sections of the plant.

### Work in India

India is now constructing a heavy-water plant on the banks of the Sutlej River. It is a combined plant to produce 14 tons p.a. as well as 70,000 tons of nitrogen fertiliser in the form of nitro-limestone (conference paper 1649). When design projects were called for, three distinct processes were put forward by tenders. An ammonia distillation process was suggested in which hydrogen, enriched by electrolysis, is converted into ammonia and then distilled to get an enriched product. Final concentration is a water distillation in a Kuhn-type column. A steam catalytic exchange system and a hydrogen distillation process were proposed. After consideration the hydrogen distillation process was considered to be the most attractive under the prevailing conditions.

Design figures give this process an overall recovery efficiency for $D_2O$ of 55.6%. The cost of plant to be erected is estimated at $2.75 million, which works out at $14.8/lb. for the capital charges. Operating costs are estimated at $12.4/lb., giving a total product cost of $27.2/lb.

A new German process which was illustrated at the Palais des Expositions stand of Degussa, is based on the isotopic exchange between hydrogen and water under pressure, in the presence of a suspended catalyst. If the plant is built in combination with an ammonia synthesis plant the synthesis gas is first scrubbed to purify it and then passes through three exchange columns in series. Hydrogen, depleted in deuterium, goes back to the synthesis plant. Water, containing a catalyst, flows countercurrently to the synthesis gas in the columns and becomes enriched up to 10 to 20%.

After the catalyst has been removed the water goes to a hydrogen generation plant and this is passed to a four-stage, hot-cold cascade distillation process in which heat losses are reduced by using heat exchangers. Degussa are now constructing a pilot plant.

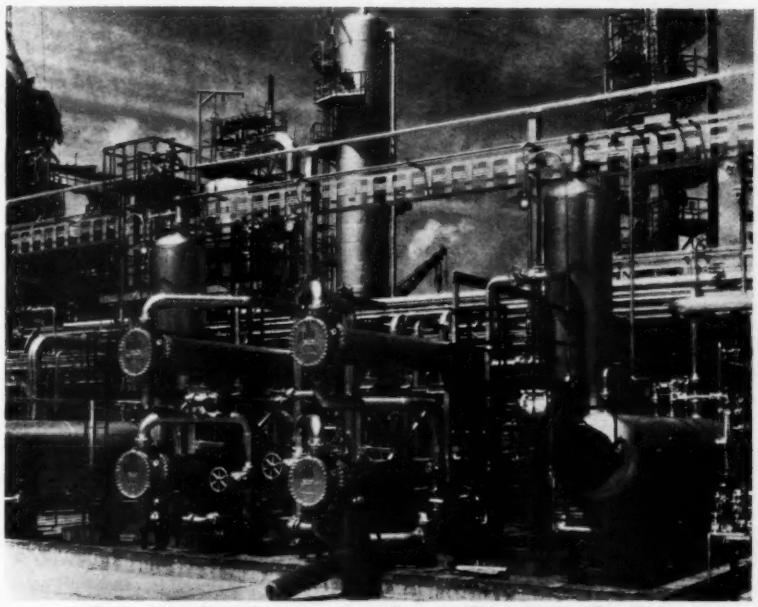
# Petrochemical Engineering Achievement at Fawley

*Esso's new £10-million petrochemical plant at Fawley is now producing ethylene, butadiene and a number of other chemical products. Features of the plant include a novel steam-cracking unit and the large-scale use of air cooling, while handling of sea-water and acid posed corrosion problems.*

OPENING of the latest addition to Fawley refinery marks the entry of Esso Petroleum Co. into Britain's new petrochemical industry in a big way. Since it started operating in 1951 with an initial capacity of 5½ million tons p.a., the history of Fawley—the largest oil refinery in the Commonwealth—has been one of continuous expansion until today it has attained a capacity of over 10 million tons p.a., with a total investment of £68 million. Esso's declared aim is to achieve self-sufficiency in refined products, eliminating importation of such products as far as possible.

The new plant, which covers an area of 600,000 sq. ft. within the refinery, will produce two principal chemical feedstocks: butadiene (42,000 tons p.a.) and ethylene (40,000 tons p.a.). Ethylene will be piped to the two nearby factories of Monsanto Chemicals Ltd. and Gemec Ltd. (Union Carbide Ltd) for the production, respectively, of polythene and ethylene-based chemicals. Some liquid ethylene will also be transported to other customers by road.

Butadiene will be piped in liquid form to the new synthetic rubber plant of International Synthetic Rubber Co. Ltd., described in CHEMICAL & PROCESS ENGINEERING last month.



**Part of the dimerisation unit of the butadiene plant at Fawley.**

### Ethylene production

Ethylene is produced by steam cracking of light petroleum fractions, the process yielding as by-products propylene, butadiene, isobutylene, normal butylene, pentylenes and cyclopentadiene. Pentanes and lighter material are removed from a light naphtha stream as the overheads in a single fractionating tower, and the bottoms are pumped as feed to the steam cracking furnaces.

The steam cracking furnaces are designed to provide a very high heat density in the radiant section. The charge of hydrocarbon is mixed with steam and passes through a normal convection section where it is vaporised and heated to about 1,000°F. After leaving the convection section it passes rapidly through a series of tubes in the centre of the furnace, in which the actual cracking takes place.

The presence of steam reduces the hydrocarbon partial pressure which favours the production of olefins and di-olefins. The material leaving the furnace is rapidly quenched by the introduction of a heavier oil, which is vaporised in the process. The short residence time at high temperatures reduces the tendency of the cracked hydrocarbons to polymerise.

The cooled products pass to a quench tower, where they are further cooled, separated from the quench oil, and pass to a centrifugal compressor before the next stage of separation. The quench oil bottoms contain excess heat which is used to raise steam in a waste heat boiler and to provide feed preheat and reboiler heat to the depentaniser unit. Other streams from the quench oil system are used in the other units which are described below.

### Product separation

The liquid and vapour streams from the compressor are separately caustic washed and passed to an absorber de-ethaniser tower, where ethane and lighter components are split off and sent to the ethylene recovery unit. The absorber de-ethaniser bottoms are fed to a debutaniser tower, and the bottoms from the debutaniser provide a naphtha stream for clay treating. The feed and the lean oil to the de-ethaniser, together with three pumparound sidestreams, are subjected to propylene refrigeration to reduce the temperature of the tower.

The debutaniser overhead product forms the feed to a depropaniser tower where separation between $C_3$'s and $C_4$'s is achieved. Propylene is the principal overhead product which is present in quite large volumes and currently goes into the gasoline polymer plant for conversion into high-octane gasoline. The $C_4$ stream passes to the butadiene extraction unit.

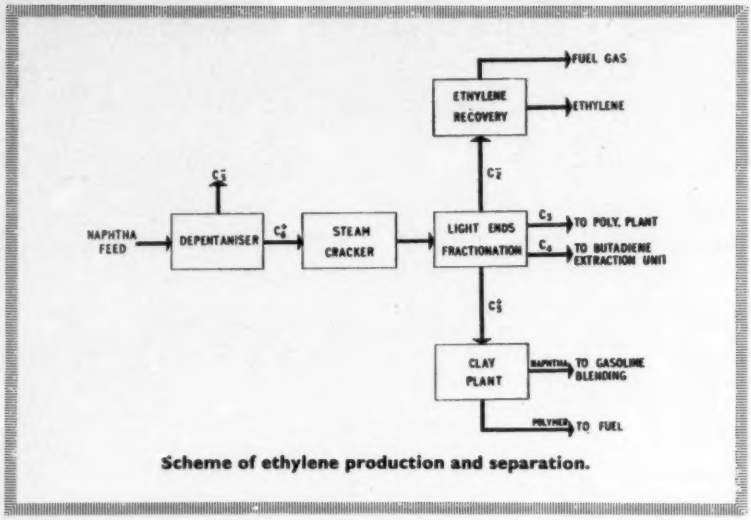
## Clay treating

The naphtha stream for clay treating is heated by a quench oil pump-around stream before passing through a clay bed. The clay treat serves to polymerise di-olefins and some olefins, which otherwise would act as gum-forming components in the gasoline. A rerun tower following the clay treatment separates the polymer from the naphtha. The naphtha is caustic washed, treated with inhibitor and sent to gasoline blending. Among possible uses for the polymer are as a core oil and in resin manufacture. At present it is sent to fuel oil.

## Ethylene purification and recovery

Low-temperature fractionation is to be used to separate the ethylene from the $C_2$'s and lighter components in the feed to the ethylene recovery unit. Compared with low-temperature absorption processes, it has the disadvantage of requiring lower temperatures and hence a heavier refrigeration duty, but it alone is capable of producing an ethylene product of the required purity.

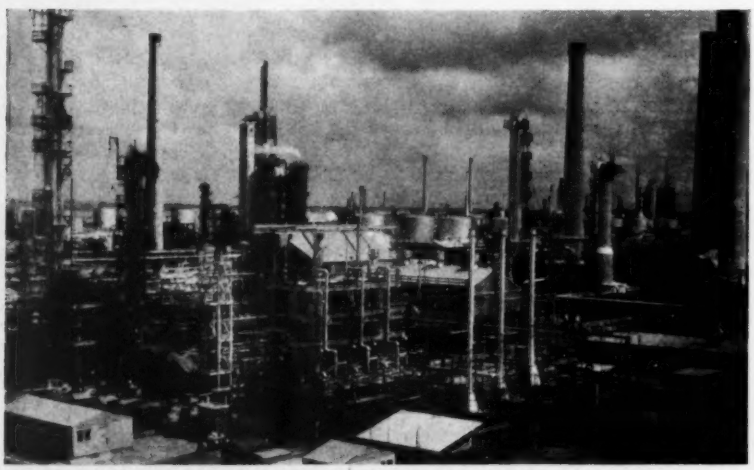
Acetylene is among the impurities for which a low concentration is essential to polyethylene manufacture, and plant has been installed to remove acetylene by selective hydrogenation over a catalyst. Steam is mixed with the feed to the hydrogenation reactors to assist in control of the reaction. Hydrogen is present in excess with respect to the acetylene, and the conditions of temperature and pressure are chosen to achieve highly selective hydrogenation of the acetylene without simultaneously converting ethylene to ethane.




**Scheme of ethylene production and separation.**

After the hydrogenation reaction, the gases are compressed, dried and cooled by passage through a series of heat exchangers, including propylene and ethylene-refrigerated coolers, before entering a demethaniser tower. Here, methane, hydrogen and a small amount of $C_2$'s go overhead at a temperature below –100°F. The overhead product is cooled and partially condensed to provide reflux. The non-condensed overheads are expanded into a Joule-Thomson flash drum. The very low temperatures thus obtained provide further liquefaction, and the liquefied material is recycled to recover its ethylene content. The vapour phase goes to fuel gas.

The bottoms from the demethaniser tower provide the feed for an ethylene-ethane splitter tower. Because of the small difference in the relative volatilities of ethylene and ethane, this tower contains 80 trays and is the tallest on the entire chemicals project. The bottoms product is almost entirely ethane, and goes to fuel gas. The overhead product is partially condensed by propylene refrigeration, and is supplied either as liquid or gaseous ethylene of very high purity.



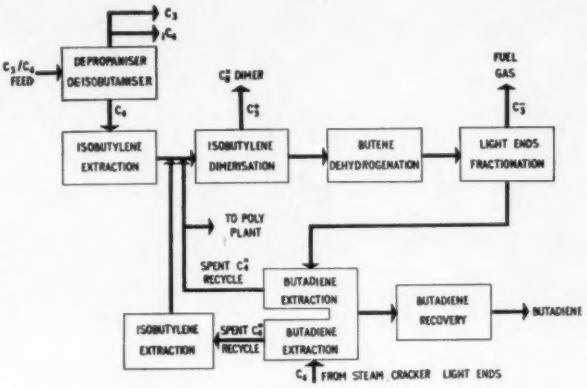
**General view of the chemicals plant at Fawley showing the ethylene purification unit, with the acetylene conversion plant in the foreground.**

## Butadiene production

Butadiene is produced by the Esso dehydrogenation process using a feedstock of $C_4$ hydrocarbons. The complete butadiene production process may be divided logically into feed preparation, dehydrogenation, butadiene extraction, butadiene recovery and the use of spent $C_4$'s. The main feed for the unit is a $C_3/C_4$ stream from the catalytic cracker; this initially contains little, if any, butadiene. Additional butadiene is recovered from a $C_4$ stream from the steam cracker, which is relatively rich in butadiene and therefore follows a slightly different cycle of treatment.

The catalytic cracker stream passes through a depropaniser tower and a debutaniser tower which are located in the catalytic cracker light ends plant. The product from the bottom of the second tower consists of mixed butane, isobutylene and butenes. These pass to an isobutylene extraction unit on the butadiene plant.

The unit comprises two extraction stages in series, with countercurrent flow of hydrocarbon and 65% sulphuric acid. The isobutylene dissolves in the acid, and the final acid extract passes to a dimer heater. Here the isobutylene is dimerised and




**Butadiene production and separation.**

the acid regenerated. Acid is separated from the dimer product in a settling drum, and the spent butenes and the dimer pass through a caustic wash to the dimer rerun tower. This is a single stage fractionating unit which removes $C_5$'s and heavier from its feed. The bottoms go to storage, while the overhead product constitutes the feed to the butene dehydrogenation unit.

### Heat exchangers

The choice of materials for heat exchangers on the dimer rerun unit, where hot acid at about 280°F. had to be handled on one side and sea-water on the other, presented problems. Carpenter 20 high-nickel chrome material was used for bundles and lead-lined steel for the shells. For other types of acid coolers *Karbate* impervious graphite was used.

### Dehydrogenation

The feed, consisting principally of normal butenes, passes through a 140-million-B.Th.U./hr. *Iso-Flow* furnace where it is preheated. On leaving the furnace, it meets superheated steam which has been preheated in another furnace and the mixture passes through a catalyst bed at about atmospheric pressure. Two reactors are provided, one on stream and one regenerating, the time for a complete cycle being about 30 min. Regeneration is performed with a mixture of steam and air.

The product from the dehydrogenation process is a rather dilute butadiene stream which requires cooling, compressing and fractionating before it is passed to the butadiene extraction unit. The final stage of the cooling process before compression employs an extensive air-fin cooler.

### Butadiene extraction and recovery

It is convenient at this point to consider the butadiene-containing stream from the steam cracker light ends as well as that from the dehydrogenation process, since both are subjected to butadiene extraction in parallel units. This stage is the first treatment which the steam cracked $C_4$ stream receives on the butadiene production plant.

Each butadiene extraction unit consists of an acetylene extraction stage followed by a butadiene extraction stage. Solutions of cuprous ammonium acetate are used in both cases for the extraction process, under different conditions of refrigeration in mixer-settler trains. The last four mixer-settler stages of the butadiene extraction are common to the two trains. Propylene is used as the refrigerant, and is compressed in a gas-turbine-driven centrifugal compresser.

Butadiene is stripped from the rich CAA solution in a desorber tower, after which the CAA solution is cooled, char treated to remove acetylene polymers and returned to the system to be used again. After water washing to remove ammonia, the butadiene product is finally rerun in a single fractionating tower, condensed overhead using propylene refrigeration, and sent to storage in spheres. It is delivered to the customer by pipeline as a liquid, at a purity of 98.5%.

The spent butenes from the steam cracked mixer-settler train pass to an isobutylene extraction unit similar and parallel to that already described for the catalytic cracked $C_4$'s feed. The normal butenes from this unit are fed to the dimer rerun tower, as also is a part of the spent butenes recycled from the catalytic cracked mixer-settler train; the remainder is returned to the refinery where it is polymerised to motor gasoline.

### Contractors and suppliers

Main contractors for the plant were Foster Wheeler, while suppliers of plant and equipment included: *pumps and compressors*—Girdlestone Pumps Ltd., Howard Pneumatic Engineering Co. Ltd., Sigmund Pumps Ltd.; *vessels and internals*—Daniel Adamson & Co. Ltd., Joseph Adamson & Co. Ltd., Ashmore, Benson, Pease & Co. Ltd., Babcock & Wilcox Ltd., Birwelco Ltd., Caston Barber Ltd., W. J. Fraser & Co. Ltd., A. Johnson & Co., Metal Propellers Ltd., Plowright Brothers Ltd., Simmons & Hawker Ltd.; *heat exchangers*—British Acheson Electrodes Ltd., Brown Fintube (Gt. Britain) Ltd; *electrical*—Crompton Parkinson Ltd., Siemens Edison Swan Ltd.; *furnaces*—Birwelco Ltd.; *instruments*—British Oxygen Gases Ltd., Dewrance & Co. Ltd., Elliot Bros. (London) Ltd., Fischer & Porter Ltd., Honeywell Brown Ltd., Richard Klinger Ltd., Sunvic Controls Ltd., Taylor Controls Ltd., Williams & James (Engineers) Ltd.; *pipes, pipework, etc.*—Audley Engineering Co. Ltd., Babcock & Wilcox Ltd., Langley Alloys Ltd., Staveley Iron & Chemical Co.; *Miscellaneous*—W. C. Holmes & Co. Ltd., Silvertown Rubber Co. Ltd., Teddington Aircraft Co.

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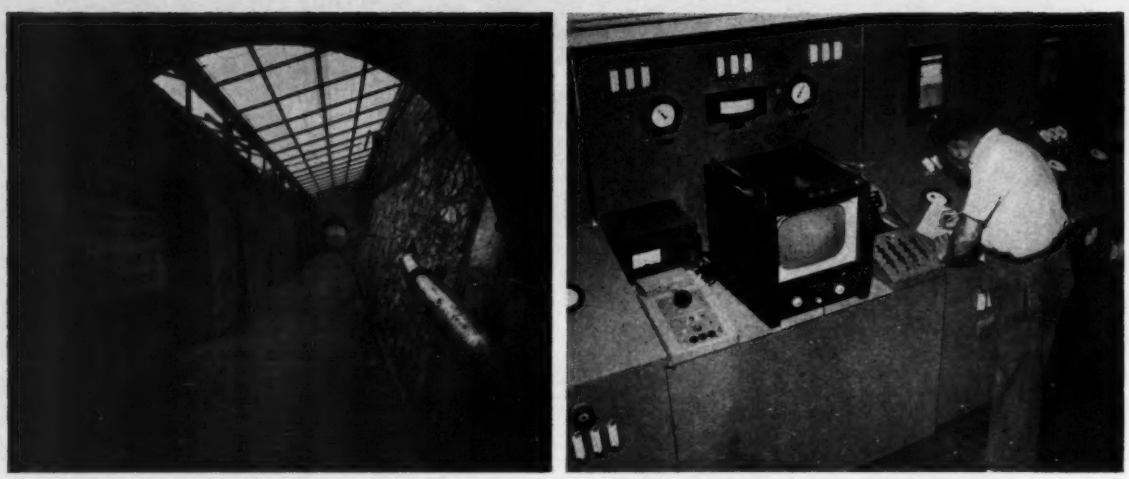
### Instruments and computers

The Institution of Chemical Engineers, the Society of Instrument Technology and the British Computer Society are to hold a joint symposium on ' Instrumentation and Computation in Process Development and Plant Design ' in the Central Hall, Westminster, London, on May 11, 12 and 13, 1959, with subjects and sessions on: improving the efficiency of existing processes; the design of new processes; the application of on-line computers; recent developments in instruments, on-line computers and computers for design; and the use of computer techniques in industry.

This meeting is being organised under the aegis of the British Conference on Automation and Computation.



**Some idea of the precautions taken in the mixing of dynamite at Montecatini's big factory at Avigliana is given by these photographs showing (*left*) a service corridor to the outside of the protective earthworks of the mixing 'grottoes' and (*right*) the protected control room for the mixing operations.**

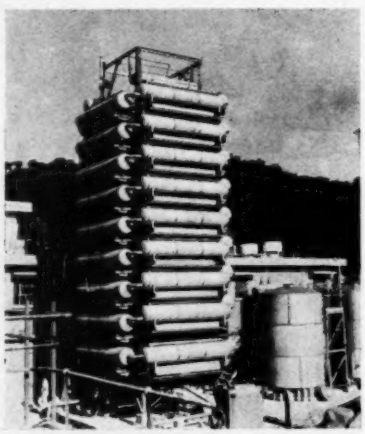
# Safer Manufacture of Explosives

*Dynamite manufacture, once an industry in which progress was slow and mishaps frequent, has been made faster, safer and more efficient by the introduction of new continuous processes and remote-control techniques. This article reviews the latest advances as exemplified in plants in Italy, Scotland and India.*

SAFETY is a dominating consideration in the design of plants for manufacturing explosives and in 95 years of industrial nitroglycerine manufacture, technological progress has been correspondingly cautious. In earlier days the industry adhered to a policy of using only the simplest equipment, reliance being placed on the human operative as the most sensitive, versatile and responsive instrument for carrying out the tricky handling and processing operations, while manufacture was organised so as to limit the amount of explosive handled at any one time or place.

However, recent progress in remote-control techniques has made it possible to equate efficient production with minimum danger to personnel, whose employment is now confined to supervisory and maintenance activities. The most impressive advances are undoubtedly those that now permit remote-control kneading of the paste —a compound of nitroglycerine, collodion, and various absorbent substances — from which dynamite is made. This operation is extremely dangerous, not only because of the presence of nitroglycerine but also because of the tenacity and elasticity of the resulting paste which exerts a considerable mechanical force on the mixing equipment.

An outstanding example of progress in this field occurs at Montecatini's big explosives factory at Avigliana, near Turin, Italy. Here, each pasting or mixing machine is contained in a steel-reinforced 'grotto' surrounded by an outer covering of specially reinforced concrete covered with an earth embankment several metres high. The fronts of the grottoes are closed by light partitions which separate them from balconies open to the sky which are intended to act as safety vents in case of explosion. These balconies are reached by galleries which are curved and sited so as to break the shock wave and blast of any explosion. The machines are automatic and driven by electric motors located in protected positions outside the grottoes.

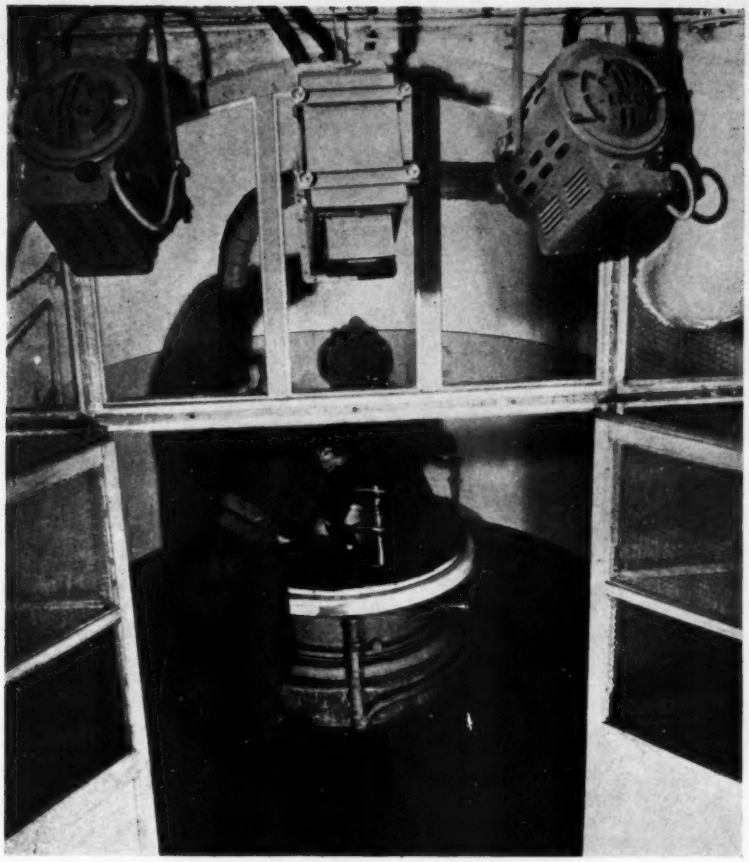


**Nitric-acid plant of 10 tons/day capacity at the explosives factory at Gomia, India. This unit, which produces nitric acid by the pressure oxidation of ammonia, was supplied and commissioned by Chemical Construction (G.B.) Ltd.**

The grottoes can be entered only when the machines are stopped for loading and unloading. The gates giving access to the galleries and balconies are fitted with interlocking locks, the keys of which must be inserted in switchboxes outside the exit from the galleries in order to complete the motor electrical circuits. The removal of one key from the switchboard automatically switches off the pasting machine.

Sound and vision controls for all pasting machines are in a protected control room, providing complete supervision. Recording ammeters, voltmeters and wattmeters continually indicate the power taken to drive the machines. Thermo-electric couples measure the temperature at a number of significant points and a microphone located near the pasting machine delivers to the control room the characteristic noises of each machine. Finally, each grotto is visually supervised by a television camera which supplies to a monitor screen a faithful picture of the mixing operation.

Another potentially dangerous pro-



**Servicing one of the dynamite mixers at Avigliana. Note television camera overhead.**

cess is the moulding and wrapping of cartridges. The machine is loaded by hand at intervals and thereafter the process is completely automatic.

### Safer nitrating processes

The actual nitration process, which comes before the kneading operation, is likewise fraught with dangers and here, too, Montecatini have adopted some elaborate safety measures. This process is carried out in a reinforced-concrete nitration chamber with electronic and mechanical devices checking and counter-checking each other so that a complete picture of what is happening is provided for the man in the control room. Glycerine is continuously nitrated and washed with water containing alkali. It is then emulsified to make it safer for handling and pumped through rubber pipes to the 300-gal. vessels some distance away, where the emulsion is left to separate.

In Britain, a considerable advance in nitroglycerine manufacture was made 2½ years ago when I.C.I. started up their Biazzi continuous nitrating unit at Ardeer, Ayrshire, this process greatly reducing space requirements and also making possible the incorporation of a comprehensive system of safety devices. The plant was described in CHEMICAL & PROCESS ENGINEERING, 1956, **37** (8), 279-280. Perhaps an even greater triumph, some time later, was the establishment of complete remote control, using television cameras, for nitroglycerine manufacture at Ardeer.

Even more recently, I.C.I. have become engaged on effecting yet another change at Ardeer—the replacement of the last of the old batch nitroglycerine plants with a plant of Swedish design known as N.A.B. In this process, glycerine and nitric acid are caused to react in an injector and the resulting emulsion is passed to a centrifuge where separation of the nitroglycerine from the spent acid is carried out. N.A.B. is claimed to give greater safety and it is stated that, in these two processes, nitrating and separating, nitroglycerine in process is only about 3% of the amount in any of the existing processes.

### Blasting explosives for India

The new explosives factory recently opened up at Gomia, India, provides further evidence of the experience that I.C.I. have accumulated. The Nobel division were responsible for the design, erection and commissioning of the plant, which will go far to making India self-sufficient in explosives for industrial blasting purposes.

A 400-ft.-high hill divides the working area for dangerous and non-dangerous operations. In the non-dangerous area plants produce sulphuric acid, nitric acid and ammonium nitrate and there is provision for concentrating the acids and for denitrating the refuse acid. Also in this area is the control and testing laboratory and equipment for making paper shells, wooden cases, and preparing non-explosive ingredients.

In the danger area, nitroglycerine manufacture by the Biazzi process, using Swiss-made equipment, is carried out.

Glycerine, supplied by soap manufacturers in Calcutta, and mixed acids are continuously fed to a nitrator in which reaction takes place very rapidly and the mixture overflows to a separator where the heavier acid settles out and is run away while the nitroglycerine overflows to a series of washing vessels to be purified to the degree required for stability. A refrigeration plant provides brine at −2°C. for cooling the nitrator.

Measuring instruments, automatic switches, electro-magnetic and pneumatically operated devices are interlinked to give visual and audible warning and stop the process. In the event of the nitroglycerine reaching an excessive temperature it will be automatically discharged out of the building and drowned in a large volume of water.

After its final purification, nitroglycerine is weighed out in the quantities required for a batch of explosives and transported to the mixing house. The solid ingredients for a batch of explosive are weighed out in the ' dope house,' mixed and sieved, passing over strong magnets to remove chance pieces of iron or steel. The mixed dope is transported to the mixing house where, with the nitroglycerine and nitrocellulose, bulk explosive is provided. This operation, one requiring particular care and attention, is done in a mixing trough with two motor-driven worm stirrers. When a mixing is completed the whole trough is inverted and the explosive, usually 1,600 lb. in a batch, drops into transport trucks underneath.

## Automatic proportioning plant for fertiliser manufacture

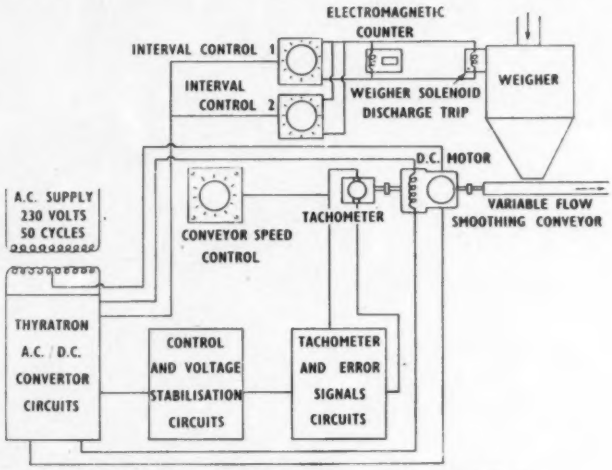
Production of granulated fertilisers started recently at the new £250,000 Stockwith works of the Farmers' Co. Ltd. at Misterton, Lincolnshire. It is ancillary to the company's main chemical works at Barton-on-Humber, and is intended to meet local demand for fertiliser. The production capacity of granulated concentrated compound fertilisers will be up to 30,000 tons p.a., working in three shifts.

An interesting feature of the plant is the automatically controlled weighing and proportioning system for the raw material. There are six raw material storage hoppers at the bottom of which are push-button-controlled conveyor belts which discharge into a dial weighing machine.

The weighing machine is of the even-arm beam type, the bucket door normally opening automatically, but the action is suspended until the electronic weigher discharge trip is released by a solenoid energised periodically by a two-interval electronic timer unit. In the timer the alternating current is rectified and regulated and the controlled d.c. voltage fed to the first-interval timing valve through a potentiometer. At the selected interval, current is passed to the solenoid and maintained for 5 sec. by the action of the second valve.

The accuracy of weighing is ±0.25% with tripping periods of 40 sec. or over. When a batch is weighed off, electro-hydraulically operated discharge gates are opened and the fertiliser is smoothed off and conveyed to a disintegrator and a mixer.

Granulation is carried out using steam from an oil-fired furnace which also provides hot air for the rotary drier. Subsequent stages of the process include cooling in a rotary cooler, screening and storage.




**Electronic control of phosphate weighing and feeding.**

# Technology Notebook

### Fellowships for research

The Ciba Fellowship Trust has been founded for the purpose of improving and increasing the interchange of ideas between scientists in the United Kingdom and on the Continent. Fellowships will be awarded by an advisory panel, consisting of Sir Arthur Vere Harvey (chairman), Prof. A. J. Birch (University of Manchester), Prof. W. Bradley (University of Leeds), Dr. A. Brunner (Ciba Ltd., Basle), Dr. E. Brunner (Clayton Aniline Co. Ltd.), Prof. D. H. Everett (University of Bristol), Prof. D. M. Newitt (University of London), and Dr. R. F. Webb, Ciba (A.R.L.) Ltd.

Several fellowships will be awarded for tenure during the academic year 1959-60 at Continental universities or institutions for research in chemistry, physics or some other allied scientific subject. They will be awarded to graduates of universities situated in the United Kingdom of Great Britain and Northern Ireland or in the Republic of Ireland, or to members of those universities graduating this year. It is anticipated that some fellowships will be awarded to recent graduates and other fellowships to candidates who have already taken their PH.D. or who have already spent some time in industry.

### Learning about radioisotopes

Over 1,000 students have now been enrolled for the standard four-week courses at the United Kingdom Atomic Energy Authority's Isotope School at Harwell. The school is part of the Isotope Division of A.E.R.E., and was set up in April 1951 to give basic training in the safe and effective use of radioisotopes as a tool in research and industry.

### Training apprentices

British industrial firms are constantly faced with a shortage of skilled craftsmen and engineers, and during recent years numerous Government pleas have been made to industry to determine future needs for technicians and craftsmen and to find ways of meeting them. One group, British Oxygen, is meeting the shortage of skilled men by providing training for its employees at all levels—apprentice, supervisory and executive. The group has paid particular attention to the training of apprentices and since 1951 a total of 175 apprentices have been handled under a special training scheme established at the firm's works at Edmonton. The firm estimates that the scheme will result in an output of approximately 120 skilled apprentices over the next five years, and it is anticipated that an increase in the training facilities which are available at present may soon be introduced.

### From arts to science

Imperial Chemical Industries Ltd. reports that the success of its transfer scholarship scheme, designed to help university students who want to change from the arts to science, has led the company to extend its guarantee of scholarship funds for a further two years to the universities which originally co-operated in the scheme. These are Oxford, Cambridge, Liverpool, Imperial College (London) and King's College (Newcastle).

In all, 65 of these scholarships are now available, the universities co-operating also including Birmingham, Bristol and Sheffield, which came into the scheme a little later.

# WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

### Graphite block heat exchanger

A new heat exchanger with an exchange area of 528 sq. ft. in a single unit has been added to the *Polybloc* models offered by Robert Jenkins & Co. Ltd. The new model can be built up from individual units having a minimum area of 37.7 sq. ft. in multiples of the same area. The makers say that units of larger area than 528 sq. ft. can be considered. **CPE 1094**

### Ceramic coatings for metals

It is now possible for coatings of ceramic materials to be applied to steel, brass, copper, aluminium, glass, plastics and other materials, the thickness of the coating being made a few thousandths of an inch or built up to 20 mm. or more. The ceramic material is specially prepared, then heated to a temperature above 3,000°F. and applied at high pressure, the part to be coated being kept cool. Various ceramic materials are available depending on the heat insulation, abrasion-resistant or electrical properties desired.

A range of standard parts and components is being offered by the United Insulator Division of the Telegraph Condenser Co. Ltd. who are also providing a service for applying ceramic coatings to parts supplied by customers. **CPE 1095**

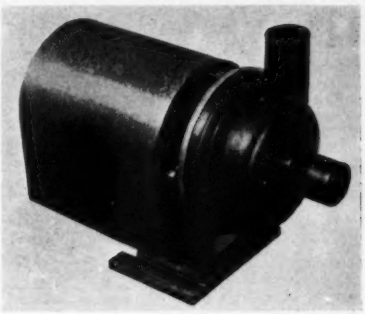
### Air-operated pump

A larger *Neumo* pump has been produced to give a maximum delivery of 1,500 gal./hr. of low-viscosity liquid at level heads through an open bore. Delivery is variable from maximum to nil. The plunger consists of a piston fitted with spring-loaded *Fluon* piston rings, ensuring even and constant pressure between ring and bore.

Such materials as liquid sugar, glue, dilute acids and solvents are claimed to have been successfully pumped. The pump is being produced in cast iron, commercial brass and stainless steel, say the manufacturers, Kingsbourne Products Ltd. **CPE 1096**

### Small pump for corrosives

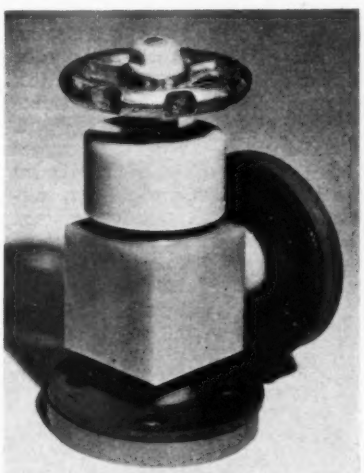
A new pump for delivering either continuous or broken flow of corrosive liquids, developed by Appleton & Howard Ltd., measures only $7\frac{1}{4}$ by $3\frac{3}{8}$ by $5\frac{1}{4}$ in. and weighs $5\frac{1}{4}$ lb. It is of the centrifugal type complete with a direct-mounted motor fitted with a guard. The pump components and the motor are held in a die-cast aluminium frame with support feet. It can be mounted on a bench or panel, or incorporated in a packaged unit. The suction and discharge branches are suitable for $\frac{3}{4}$-in. bore rubber or plastic hose.



Corrosives pump.

The motor is of the shaded-pole type suitable for an electrical supply of 230/250 v., single-phase, 50 cycles, or 50 or 100 v., 50 or 60 cycles a.c. It has an automatic resetting thermal overload device to guard against the possibility of a winding failure.

The pump body and impeller are made of high-density polythene and the shaft sleeve is of high-grade stainless steel. The standard unit has a synthetic-rubber lip-type shaft seal. The rate of flow for fluids of similar viscosity to water at normal ambient temperature is 5 gal./min. against a head of 2 ft., or 1 gal./min. against a maximum head of 11 ft. **CPE 1098**



**FINE-ADJUSTMENT VALVE**

*This new fine-adjustment valve, in plastics, has been introduced by the Chemical Pipe & Vessel Co. Ltd. With a* Fluon *seat, it can be used for corrosive liquids up to* 65°C. **CPE 1097**

### Glassware sets and packaging

A new method of packaging and a new comprehensive range of laboratory glassware assemblages have been introduced by Quickfit & Quartz Ltd. Fitted blue plastic trays of sandwich construction totally enclose the glassware in the minimum possible space. The trays are designed to fit into the standard laboratory bench drawer or cupboard. Alternatively, the plastic trays can be retained in the box in which they are dispatched and stored one above the other. The fitted trays

**C.P.E.'S MONTHLY REPORT AND READER SERVICE**

make it possible quickly to spot any broken or missing components and each component has its reference number moulded into the tray.

The new assemblages comprise a progressive series of interchangeable sets, from gramme to kilogramme size and ranging upwards in content from a set of five pieces. All components are standardised *Quickfit* parts. Each assemblage is claimed to cover the widest possible range of techniques while keeping the number of different parts to a minimum. **CPE 1099**

### *Liquid heat pump unit*

A range of liquid heating plants of up to 3 h.p., using a hermetically sealed air-to-liquid heat pump, is now being produced by Temperature Ltd. These *Temkon* units operate over a wide range to supply 150 gal./hr. of liquid at temperatures up to 120°F.

By using heat from the outdoor air, the equipment provides heating equivalent to 2½ times the total watts absorbed by the machine, say the manufacturers. The heating plants are automatic in operation and suitable for built-in or remote thermostatic control. An outdoor defrosting system enables the plant to work at full capacity even when the outdoor temperature is below freezing point. The circulating pump has a *Neoprene* impeller, and will handle a wide variety of liquids at external heads up to 30 ft. The rating of each unit varies according to the required water temperature; a typical duty would be 18,500 B.Th.U./hr. with outdoor air at 40°F. **CPE 1100**

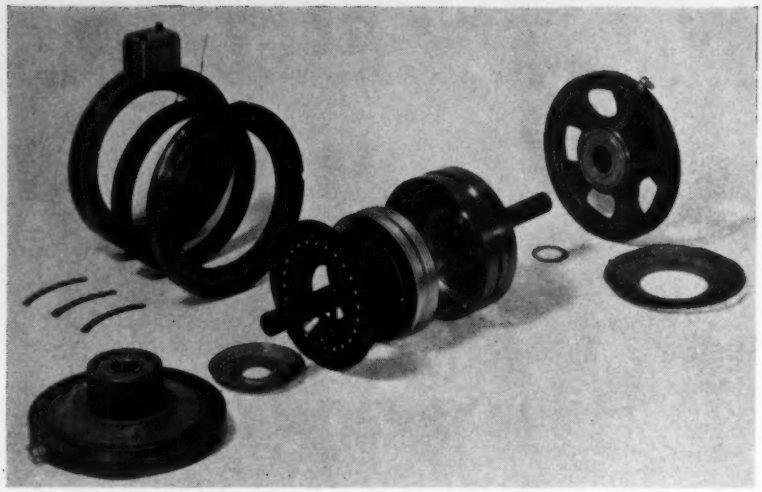
### *Servo components*

Two new ranges of servo motors have been developed by Evershed & Vignoles Ltd. The first range conforms to international and N.A.T.O. standards in both dimension and performance, while the second consists of units based on long-established designs but adapted to provide fixing and mounting facilities, shaft details, etc., in compliance with international standards.

D.c. servo motors can now be supplied with field windings requiring from 50 to 1,500 ma. for full torque. The preferred values are 50, 80, 200, 500, 800 and 1,500 ma. Armatures can be wound for 220, 110, 50 and in some cases 28 or 24 v. supplies. Armature supply units PA11 series for connection to 230-v. 50 to 60-c/s supplies are now available for most d.c. motors.

A.c. motors and motor/generators are available with windings for 50-v. 50 c/s or 115-v. 50 to 60 c/s supplies. Control windings for direct coupling to the output stages of valve or transistor amplifiers have been developed. For the transistor windings the preferred collector to collector voltages are 15-v. 50 c/s and 24 v. 400 c/s, but alternative voltages could easily be accommodated if required. Most motors can also be wound for three-phase supplies.

The range of amplifiers to control servo motors has also been extended and type PA25C d.c. amplifier is suitable for all Evershed split-field motors. This amplifier produces full torque with an input of 250 mv. d.c., and has an initial gain of 600 ma. per volt. For 50 c/s a.c. systems amplifiers of 6, 12 and 28 w. output are available. **CPE 1101**



**MAGNETIC PARTICLE COUPLING**

*An electromagnetic coupling for industrial drives from S. Smith & Sons Ltd., mentioned in our November issue. Components are (top left) stationary field member and winding, (left) output member, (centre) shafts and (right) output member. The coupling is stated to have the resilience of its fluid flywheel counterpart with the stability of a solid device.* **CPE 1056**

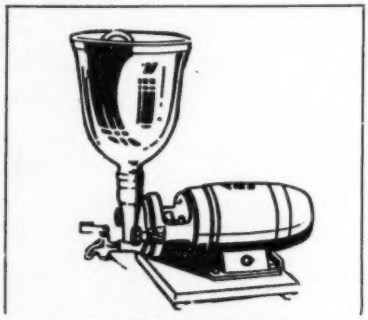
### *'Monel' clack for steam/water mixing valve*

Longer working life is achieved in the redesigned Meynell steam/water mixing valve with the introduction of a *Monel* metal clack, which now replaces the original cast-nickel-alloy clack. The function of the *Monel* clack is to close on to the *Fluon* seat in the steamway.

A further improvement in this valve, offered by Meynell & Sons Ltd., is the introduction of phosphor-bronze leaf jets which permit a fine control of water throughout over a wide range of pressures. Previous jets were either in moulded rubber or brass, materials which rendered the valve less sensitive than the new model. **CPE 1102**

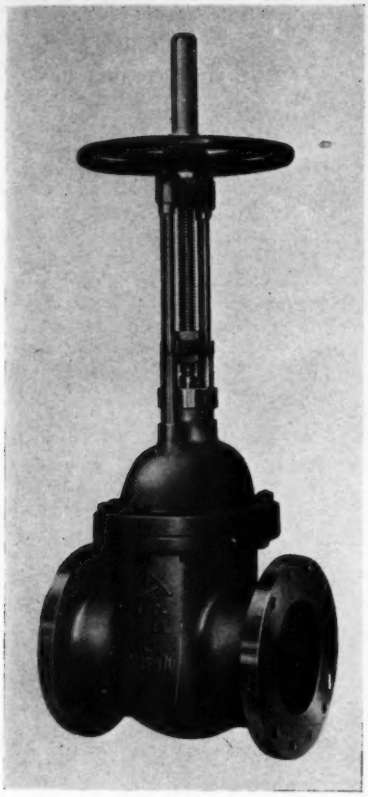
### *Parallel slide valves*

Parallel slide valves in cast steel are now available from the Triangle Valve Co. Ltd., these being of the rising spindle, outside screw type and having spring-loaded discs. The springs are



**ELECTRIC MIXER**

*This homogenising and emulsifying machine, some details of which were given in our October 1958 issue, is manufactured by Heinz Gaebelt, Germany, and is available in two types, one being for laboratories and small-scale production and giving an approximate output of 200 to 300 quarts; the other giving approximately 600 to 900 quarts.* **CPE 1023**



Cast steel slide valve.

for retaining the discs in contact with the seats during all conditions except for the last movement of closure. This feature wipes the seats clean during intermediate travel and permits a clean contact between the outlet (downstream) disc and seat faces. The shut-off of this valve is thus commensurate with the line pressure.

On sizes up to 4 in., limited alignment is provided by male/female or telescopic connection of the two discs, whilst on larger sizes a similar function is provided by a carrier ring (belt ring) and a disc clip. The ring is of stainless steel to avoid rust which otherwise precludes free rotation of the disc; the carbon-steel clip prevents undue outward movement of the discs when in the open position. A steel stop or crosshead is keyed to the spindle to prevent rotation and slides between two steel pillars provided with collars limiting the travel. A bridge at the upper end of the pillars carries the sleeve which will not permit the stem assembly to fall if, for any reason, the handwheel is removed with the valve open. A three-bolt gland is featured giving even adjustment and the gland skirt protects the studs from atmospheric damage. A tubular cap completes the assembly, giving protection to the upper portion of the stem. **CPE 1103**

Fabric bulk liquid container with 800-gal. load.

## Drums lifted and tipped

Trucks with squeeze clamps, introduced by W. Langley & Co. (Mechanical Handling) Ltd., will lift drums weighing up to 5 cwt. to a maximum height of 6 ft. 6 in. and turn them through 180° at any intermediate height. These models can be adapted to take drums up to 10 cwt. and to lift to a height of 10 ft.

Hydraulically operated by hand, battery or mains power, these trucks have been designed specifically for the operation of lifting drums over vats and pouring at a controlled rate.

Applied to the stacking of drums, bales and similar objects, they also provide a means of obviating, in many instances, the need for palletisation. **CPE 1104**

## Flexible bulk liquid containers

A development in lightweight and flexible bulk liquid containers, introduced by Marston Excelsior Ltd., is made from coated strong woven fabrics with a black or white finish. Bulk liquids can be conveyed by normal road, rail or water transport. On the return journey the empty tank can be rolled up into a small bundle and the full load space used for other cargo.

*Portolite* tanks may be strapped on to the flat surface of an open-sided vehicle or placed within the walls of a vehicle with sides. The tanks are suitable also for storage on unmade ground and, empty, they can be stored without special packaging precautions. They are available with filling and emptying connections to meet individual needs and are normally filled on the vehicle or on the site.

The method of cleaning depends on the contents of the tank. Steam and detergents may be safely used, while in some cases a second fitting may help to dispose effectively of steam and condensate.

Owing to widely differing requirements, the fabric of the *Portolite* tank will be governed by its contents. These include petrols, mineral oils, vegetable oils, water, latex, chemical salt solutions, alcohols, detergents, molasses, alkaline solutions, ketones, esters, dilute acids and fruit juices. **CPE 1106**

### GLASS HEAT EXCHANGER

An improved, condenser-type heat exchanger announced by Q.V.F. Ltd. is more compact and possesses a much higher heat-transfer efficiency than its predecessor, while the price is considerably reduced. Thinner-walled tubing has been utilised and, under favourable conditions, the overall heat transfer is increased by 30%. **CPE 1105**

## Automatic temperature control in batch production

Fully automatic temperature control in the production of 1,000-gal. batches of polyester resin is a feature of a plant recently commissioned at the Oldbury works of B.I.P. Chemicals Ltd. The plant itself is of conventional design but the control system is of a special design that might be applicable to other processes, including those in which it would be necessary to determine the end point for individual batches by other means.

Principal units of the control system, designed by Hygrotherm Engineering Ltd. in collaboration with Negretti & Zambra Ltd., are a programme controller and a slave controller. The programme controller compares the required batch temperature, as determined by a cam profile, with the actual

batch temperature. The output signal deviates from 9 p.s.i. by an amount depending on the difference between the actual and required batch temperatures. This output air signal from the programme controller sets the control point of the slave controller.

Next, the slave controller regulates the temperature of the heating medium admitted into the reaction vessel jackets. The output signal of the slave controller depends on the deviation of the heating medium temperature from the temperature corresponding to the signal received from the programme controller.

Batches are controlled to within ±1°C. of the required temperature.

**CPE 1107**

### Plywood pack for carboys

A combination of strength and lightness is achieved in a new pack for carboys of acid and dangerous chemicals which consists essentially of a plywood barrel with an inner plywood sleeve insulated against the exterior wall by bands of rubber, with rubber cushions at the top and bottom.

Two $\frac{7}{8}$-in.-diam. steel rings are secured to the top outside face of the inner sleeve which extends to $2\frac{1}{2}$ in. below the top exterior. These rings are used to secure the carboy in position with wire or cord. The lid is secured with double closing hoops. An inner disc has a 4-in.-diam. centre hole to take the neck of the bottle and the whole is secured by three topple fasteners.

The barrel, produced by Venesta Ltd., is at present available $24\frac{1}{4}$ in. high, the inside depth between cushions being $21\frac{1}{4}$ in. and the inside diameter of the sleeve 12 in. **CPE 1108**

### Cold junction box

A cold junction box, for use when a large number of thermocouples are sited an appreciable distance from their indicating or measuring points, has been introduced by Sunvic Controls Ltd. The unit can be installed on the plant and thermocouple leads gathered to it for automatic compensation. The distance from cold junction box to indicating/measuring point can then be covered by ordinary copper cable.

The cold junction box, it is claimed, gives greater accuracy than normal methods of compensation, and is usually set to maintain a temperature of 60°C. ± 0.1%. The unit accommodates 16 pairs of copper constantan leads, the 16 compensating cables and a cold junction thermostat. A test thermometer can be inserted to check the performance of the latter. The case is dustproof and measures 11 in. wide by 20 in. high by 6 in. deep overall. **CPE 1109**

### Liquid or gas valve

Valves which can be used for handling viscous and gritty liquids, recently introduced in the U.K., have a smooth full-way passage which avoids any tendency to turbulence. They operate in either direction of flow, and the seal permits no leakage of liquids or gases at listed duties. The absence of internal lubrication ensures that liquids or gases passing through are uncontaminated.

There are no wearing parts and all moving parts are chromium plated to resist rust and obviate sticking. Moving parts are not in contact except through seals, which are available in a variety of materials. Where required, remote control can be arranged, as the operating lever has a 90° movement.

The valves are available in sizes ranging from $\frac{5}{32}$ to 8 in. diameter. In the small sizes, they are suitable for pressures up to 5,000 p.s.i. Makers are Hydraulics & Pneumatics Ltd.

**CPE 1110**

### Titanium heating coils for chrome vats

Coils made from titanium tubing are now being advanced as a convenient method of heating chrome-plating vats. Titanium, as strong as steel and half the weight, is completely inert to chromic acid hot or cold, and steam coils with a wall thickness of the order of 20 s.w.g. will last indefinitely. According to I.C.I., who supply titanium tubing of various diameters and gauges, users have reported that vats can be heated with titanium coils in 25% less time than with lead coils of the same size.

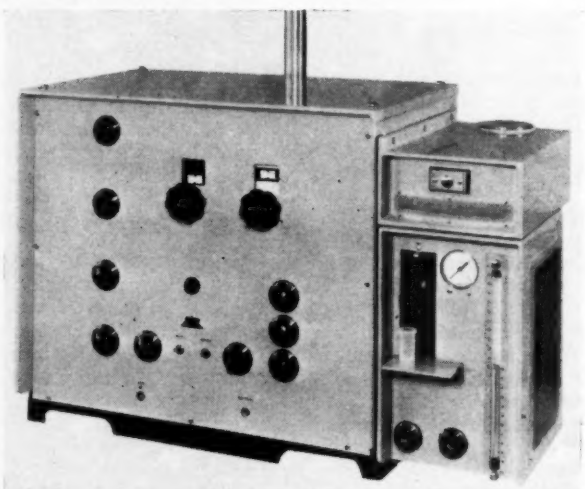
The strength and lightness of titanium make simpler designs possible: supporting struts are usually unnecessary and a titanium coil weighing only 5 or 6 lb. has the same heat-transfer capacity as a lead coil weighing about a hundredweight. It is claimed that, although titanium is a much more expensive material, because it is so easy to fabricate and because the components can be made many times lighter than in lead, in actual practice a titanium steam coil for a given duty costs little more than a lead one and lasts much longer in service.

**CPE 1111**

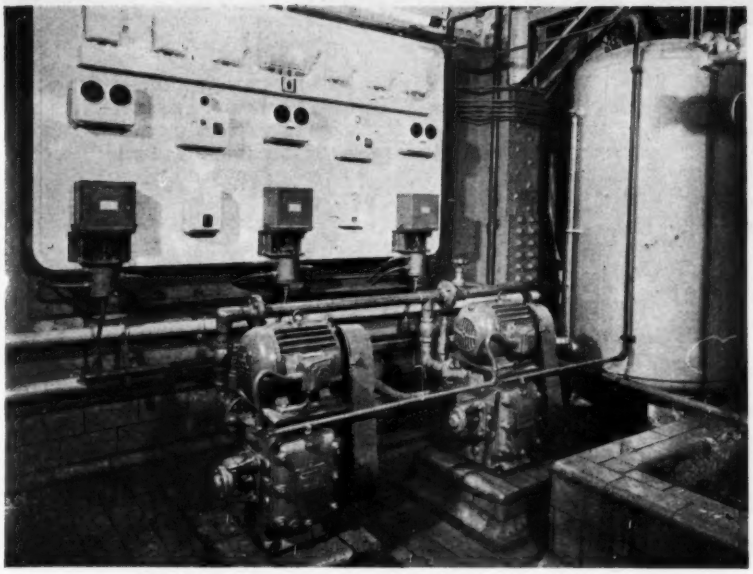
### Flame spectrophotometer

Flame photometry is a well-known technique for detection and estimation of small proportions of certain metals. The power range and versatility of a new model, by Unicam Instruments Ltd., together with simplicity of operation, make it suitable for a variety of industrial uses.

The sample is dispersed by a concentric jet atomiser and introduced into a flame provided by a mixture of compressed air and propane or acetylene. Light passes through a monochromator to the photocell or photomultiplier detector; the signal is amplified and displayed as a direct reading of emission line intensity on a spot galvanometer. An alternative output suitable for operating recorders is provided. **CPE 1112**



**Flame spectrophotometer for identification and estimation of metals.**



**Automatic pressure system installed by Middlewich Salt Co. Ltd.**

## *Hydraulic operation of salt valves*

An automatic pressure system to provide a constant water supply for the hydraulic operation of salt valves has been installed recently by the Middlewich Salt Co. Ltd., Cheshire. The valves, which are an essential part of the plant used in the production of salt, are operated on a time cycle by water supplied from a pressure vessel at a pressure of between 65 and 80 p.s.i. The required pressure is maintained automatically in the vessel by two *Megator* M16 cast-iron sliding-shoe pumps, main and standby, each capable of supplying 800 gal./hr. of water at a maximum working pressure of 85 p.s.i.

In the pressure lines between the pressure vessel and the three salt valves is the control panel, on which are mounted three solenoid-operated changeover valves operated by time switches. During the cycle of operation, each changeover valve in turn admits water under pressure to the appropriate salt valve.

The pressure system equipment, comprising pumps, pressure vessel, pressure switches, automatic starter and selector switch, was supplied by Megator Pumps & Compressors Ltd.

**CPE 1115**

## *Corrosion-resistant coating for heavy duty*

Resistance to severe corrosive conditions, involving both acid and alkaline fumes with very high humidity, is claimed for an epoxy-based coating, *Epiglo* C, introduced by Corrosion Ltd. According to the makers a two-coat system using this coating showed no sign of failure for over two years at a large chemical works, the coating being subjected to continuous spraying with water for months on end.

It is further stated that, when the coating has been applied to the outside of ammonia tanks, ammonia spillings within 24 hr. of application have had no adverse effect on the coating, while for steelwork, floors, etc., in a viscose plant the coating has given satisfactory resistance to high concentrations of sulphuric acid at elevated temperature.

**CPE 1113**

## *Dial thermometer*

Designed to replace the brass-cased glass thermometer the *Clyde* V.B. industrial dial thermometer is compensated against creep due to heating or cooling of the case. Manufactured by Buchanan Bros. Ltd., the latest models are fitted with the new *Easiread* scale which enables readings to be taken at considerable distances. The thermometer consists of a bi-metal element which operates through a movement. By means of this movement the instrument can be calibrated accurately over its entire range.

No glass is used on the V.B. thermometer which means that, if it is dropped, damage is confined to the brass bezel. A 3-in. dial is used.

**CPE 1114**

## *Conveyor-belt brush unit*

Claimed to provide an efficient means of cleaning conveyor belts, the K.A.M. unit can be installed on existing fittings, generally with only four bolts. It is stated that, in a recent example, a brush running at 100 tons/hr. showed no appreciable signs of wear after 4,000 hr. running, the driving power being supplied by a totally enclosed, three-phase, 50-cycles electric motor operating on 400 to 450 v.

A flameproof unit is available, although it is stated that little or no guard is required for these units under ordinary circumstances. Materials that can be handled include coal, coke, iron ore, glass fragments, concrete slurry, raw sugar and sinter.

Further details can be obtained from the Kleen-E-Ze Brush Co., or by filling in the reply-paid card.

**CPE 1116**

## *Brush-applied rubber sheathing*

A new coating, *Treoprene* 2C, is offered as an answer to the problem of applying an *in situ* protective lining or sheathing for metals and concrete exposed to unusually severe chemical attack. A film thickness of 15 to 20 mils—equivalent to 15 or more coats of paint—is obtained in a two-coat brush application of this protective system (on primed surfaces) which can be applied by normal site labour.

The coating is based on a synthetic rubber (*Neoprene*) compound which has an abrasion resistance akin to that of a very tough rubber and is made by Tretol Ltd. **CPE 1117**

## *Electronic thermo-switch*

A newly developed electronic thermo-switch by A. M. Lock & Co. Ltd. is now available. The temperature elements of the switch are interchangeable and sensitive, consisting of a platinum winding, housed in a thin stainless-steel tube.

The instrument is designed to maintain temperatures at a pre-set value, which gives immediately relay action

for any tendency to deviate from this value. Any variation will result in the platinum sensing element producing an out-of-balance signal in the electrical bridge network, either in or out of phase with the bridge voltage, depending upon the sense of the temperature change. The signal is then amplified and applied to a phase-sensitive detector which operates a heavy-duty control relay, making or breaking, according to whether the measured temperature is lower or higher than the pre-set position on the control knob. **CPE 1118**

### Seals for abrasive services

Crane Packing Ltd., who some time ago announced the development of seals with hard metallic faces for abrasive services, report that a type 1A seal with a tungsten carbide seal face has operated with complete satisfaction handling a suspension of magnesium hydroxide at a pressure of 140 p.s.i. The seal was installed in a Sigmund B-NE 5 pump, operating at 2,900 r.p.m. **CPE 1119**

### Flexible heater for pipes

A flexible heating cable which can be coiled round pipes and fittings to compensate for heat loss consists of four parallel conducting cores extruded in a PVC sheath. It can be used, for example, to maintain viscous liquids at certain temperatures to keep them free-flowing.

The cable, which is flat and approximately $\frac{1}{2}$ in. wide, is available in lengths of 50, 25 or $12\frac{1}{2}$ ft. for operation on mains voltages, connectors being provided at both ends of each length so that, as circumstances demand, heaters can be readily joined together up to a total of 4 × 50 ft. lengths.

Other applications are frost prevention and immersion heating, and liquids can be raised to a temperature of 65°C. The makers are Electrothermal Engineering Ltd. **CPE 1120**

### Automatic welding of cylindrical vessels

Increased production of welded rotary kilns, storage tanks, H.P. and L.P. heaters, rotary coolers and other cylindrical fabrications with a wide range of sizes is now being obtained at the Barrow-in-Furness works of Vickers-Armstrongs (Engineers) Ltd with the aid of a *Fusarc* high-lift boom and traversing roller bed installation. The high-lift boom equipment consists basically of a boom 17 ft. 6 in. in length, one end of which is mounted so that the height of the boom above the roller bed is variable. At the other end of the boom is a *Fusarc* automatic welding head.

The roller bed can support, turn and traverse a weight of up to 48 tons, and is adjustable to accommodate vessels with diameters ranging from 2 to 15 ft. Both the turning and traverse motions are controllable at welding speeds, so that both longitudinal and circumferential welds may be carried out by moving the workpiece while the welding head remains stationary. Power is supplied by a Quasi-Arc 1,000-amp. generator, and *Seamec No.* 2 continuous covered electrode of the *Fusarc* type is used, at currents up to 750 amp. for internal welding and 900 amp. for external welding. **CPE 1129**

## ★ American Developments in Brief ★

A small production mill, specially designed for small to medium-size manufacturing plants, has been announced by Morehouse International. It is capable of producing many types of product in volumes up to 400 litres/hr. by high-speed attrition grinding between specially formulated self-sharpening stones with a clearance to within 0.001 in. **CPE 1121**

★ ★ ★

Three new sizes have been added to *Karbate* impervious-graphite shell and tube heat exchangers by Union Carbide International Co. They have 8-, 42- and 45-in.-diam. shells. **CPE 1122**

★ ★ ★

Aimed at the achievement of faster curing systems for rubber and plastics, Union Carbide International Co.'s latest offer is molecular sieves which have curing aids contained within the pore structure by strong adsorptive forces. At curing temperatures the active compound is released to accelerate the curing action. **CPE 1123**

★ ★ ★

An impervious-graphite piping system composed of standardised pipes and fittings can be fitted in the field with only a hacksaw and a wrench. The system, by Falls Industries Inc., utilises glass-fibre armour. **CPE 1124**

★ ★ ★

A series of continuous-duty metering pumps that transfer liquids and gases through plastic or rubber tubing at exceptionally slow rates and with predetermined accuracy are being produced by New Brunswick Scientific Co. **CPE 1125**

★ ★ ★

A new chemical compound, sodium β-sulphoproprionitrile, for use in the manufacture of pharmaceuticals, surface-active agents, etc., is announced by American Cyanamid Co. It is derived from acrylonitrile, melts at 234 to 244°C. and is soluble in water, glacial acetic acid and hot methanol. **CPE 1126**

★ ★ ★

Combination of *Hastelloy* alloy C and a ' truing-up ' technique has extended the operating life of mixer turbines from six months to two years, report Union Carbide International. The turbines operate in a mixture of hot sulphuric acid and phosphate rock in mixer tanks. Phosphoric acid is produced in a reaction which is both corrosive and abrasive. **CPE 1127**

★ ★ ★

The first water desalting plant to serve a U.S. city is being installed at Coalinga, Cal. The plant uses the electrodialysis system of Ionics Inc., which can freshen waters with one-thirtieth to one-third as much salt as sea-water. Special plastic membranes are used in this system. **CPE 1128**

### Automatic quality control

On-stream, quality-controlled production is possible with equipment now being manufactured in Britain and which comprises a series of modules, variable in accordance with processing requirements. Through continuous chemical analysis, continuous control of product composition is effected.

Manual operations of the laboratory are reduced to automatic procedures, integrated into a continuous flow system in the plant, and results are permanently recorded. Plant control is achieved by fitting switches, slide-wires, or pneumatic pilots to the recorder, which can also feed digital computers, punched-card systems, etc.

Makers are Technicon Instruments Co. Ltd. **CPE 1130**

### Heavy-duty butterfly valves

Compact, heavy-duty butterfly valves for use with air, gases, liquids and semi-solids are now being manufactured in the United Kingdom by Cockburns Ltd. These valves are made to the American *Rockwell* pattern and are claimed to give wedge-tight shut-off at pressure differential to 150 p.s.i.

The standard valves are made of high-strength cast iron with carbon-steel shafts, but valves in other metals are also available. Valve bodies and discs may be coated with rubber, *Neoprene*, glass, plastics, etc. Standard cast-iron valves are suitable for service from –50°F. to 210°F., but they can be built to meet other temperature conditions. The valves are equipped with operators which may be of the manual or automatic type.

For service where bubble- or drop-tight shut-off and/or resistance to abrasion or corrosion are required, valves are available with a spool-type rubber liner which completely covers the valve body interior and forms a gasket on the flange faces. Both effect tight shut-off when the valve disc seats at 90° to the axis of the pipeline.

**CPE 1131**

### Rollerless gravity conveyor

An easily constructed conveyor that can be ' tailor-made ' to suit different needs is being marketed by Dexion Ltd. The framework is made from *Dexion* slotted angle, punched strap is used to form corners and curves and *Glidewheels*, fixed to the slotted angle at regular intervals, eliminate the complication of fitting tapered rollers when setting up bends.

It is stated that, because of the ease with which the *Glidewheels* rotate, the slope required for smooth running of the conveyor is reduced and packages of varying weight can be carried without the need for variation in the height of the conveyor supports. **CPE 1132**

### Liquid cooling plant

Liquid cooling plants up to 3 h.p., based on an hermetically sealed refrigeration system, are available, being designed to cool liquids to temperatures between 15 and 75°F. Manufactured by Temperature Ltd., these units are self-contained and fully automatic. Close thermostatic control makes them suitable for chemical processing, photographic work and industrial cooling.

The plastics-bodied pump will handle a variety of liquids at external heads up to 30 ft. and is rated at 150 gal./hr. Models are available for temperate or tropical climates, and the sealed-system refrigeration unit is fitted with either an air-cooled or water-cooled condenser.

Plant capacity varies according to the demands of each installation; a single unit will normally have a cooling capacity of about 20,000 B.Th.U./hr. Higher loads can be dealt with by two or more plants operating in parallel, with interlocking controls.

**CPE 1134**

### Electrolytic conductivity controller

Measurement and control of the conductivity of electrolytes such as weak acids, processed water, steam condensate, etc., are made possible by a new instrument. It is intended primarily for permanent installation on processing plant, during the operation of which it is required to signal, or to effect corrective action, when the continuously monitored conductivity of an electrolyte reaches a predetermined value. The instrument may also be used to make periodic measurements to enable the state of the process at any time to be accurately appraised. The controller is connected to a measuring cell that is immersed in the electrolyte, or which forms a part of the pipeline carrying the electrolyte.

Electrical conduction takes place through a precisely known volume of the solution, the volume being determined by the dimensions and spacing of electrodes that are continually immersed in the solution within the measuring cell. Small variations in the concentration of weak acids, or in the content of soluble inorganic impurities in water, produce substantial conductivity changes that are sensitively detected by the instrument and are thereby caused to actuate a relay which may be connected as required to operate visual or audible signals. For the purpose of automatic control, the relay may switch valves or pump motors related to the transfer of additives, or the admission or withdrawal of solution to or from the system. Makers: Electronic Switchgear (London) Ltd. **CPE 1135**

**DEMINERALISER**

*Demineralised water in small quantities is produced from clean, cold piped water by Permutit's Mark V portable 'Deminrolit' plant shown here.* **CPE 1133**

### Hydraulic two-stage tube-bending machine

Chamberlain Industries Ltd. report that extensive modifications have now been made to their hand-operated, two - stage, hydraulic, tube - bending machine.

To allow close offset bends to be made without any fear of bending or displacing the hydraulic ram, the unit is now fitted with an improved type of forming head. In addition to the standard series of holes for positioning the end formers to carry out ordinary bends on steam and gas tubes from $\frac{3}{8}$ to 2 in. nominal bore, the forming head has now been enlarged and modified with an additional series of holes provided so that when the end formers are staggered and located in the appropriate position equidistant from the centre line of the ram, ' offset ' bends can be produced. A chart is provided which will act as a guide to the operator when carrying out this type of work.

A further modification has also been made to the end formers to produce progressive ' drag ' on the tube to ensure that it seats snugly in the bending former groove. The advantages of these arrangements are particularly noticeable when working on heavy-walled or solid-drawn materials, and where the tendency is for the tube to leave the die when under extreme pressure. **CPE 1136**

### Flexible pipe couplings

Flexible pipe couplings which are stated to be suitable for marine and other installations subject to vibration, and for fuel, hydraulic, pneumatic and lubricative systems, have been introduced under the name of *ACFlex*. They are claimed to accommodate tube misalignment up to $\frac{1}{16}$ in., tube

separation up to ½ in., and to allow ±4° tube flexure. They eliminate the necessity for metal bellows in pipe runs and, as they can be installed after tubes are in place, the structural apertures need be no larger than the standard bead on the tube. An axial movement of 0.35 in. is permissible and the couplings can function as slip joints.

Further details are available from Aero Controls Ltd. or by using the reply-paid postcard. **CPE 1137**

### *Fume exhaust fans*

Centrifugal performance and axial flow are combined in the *Bassaire* range of PVC fume exhaust fans. The motor is flange mounted to a heavy support plate attached to the fan casing with high-impact unplasticised PVC bolts, permitting the motor and impeller to be withdrawn as one unit, leaving the casing undisturbed.

No metal surface in the fan casing is exposed to fume-laden air. Where fume concentrations are slight, fans are available in steel, lined internally with a stoved PVC finish. The range starts with a No. 6 fanset designed for direct incorporation into the construction of all standard 2 ft. 6 in. and 3 ft. fume cupboards. Other sizes and speeds, including belt-driven models, are available from the suppliers, B.M.B. Sales Ltd. **CPE 1138**

### *Jerrican pourer*

A new lightweight pourer with a cast aluminium body has been specially designed to fit the claw-type neck of a 4½-gal. jerrican. Two steel claws hold the pourer rigidly in place, whilst the *Neoprene* seal in the base ensures leakproof service. A breather tube is provided. There is a lug on the upper surface of the spout to secure the pourer to the jerrican if required.

The pourer is supplied with a coarse gauze for use with dirty fuel or chemicals and a very fine, water-repellent gauze for separating fuel and water by retaining the water in the can. The inside of the 7-in. spout is tapered from 1⅛ in. down to 1 in. in order to accommodate a rubber tube to facilitate pouring into an awkwardly placed receptacle. Makers are J. E. Lesser & Sons Ltd.

**CPE 1139**

### *Beneficiated hectorite*

A beneficiated magnesium-lithium silicate, mineralogically known as hectorite, is available under the name of *Macaloid* for use in absorption, purification, flocculation, gelling, suspension of pigments and powders, stabilisation of emulsions, etc. It is produced by grinding raw hectorite ore to a coarse powder, then slurrying with heated deionised water to form a thin gel from which impurities such as calcite, dolomite and silica crystals are centrifugally separated. The slurry is dried and ground to form thin, readily dispersible flakes.

When fully hydrated *Macaloid* will swell from 35 to 40 fold. Its ultimate particle size is as small as 1 millimicron thick, 70 millimicrons wide and 700 millimicrons long, and the surface area of 1 g. is 1,000 sq. m. The exchangeable ion is sodium and the ion exchange capacity is 100 meq./100 g. The suppliers are Production Chemicals (Rochdale) Ltd. **CPE 1140**

## RECENT PUBLICATIONS

**Pumps** in great variety are illustrated in a new brochure by Sigmund Pumps Ltd., Team Valley, Gateshead, which starts with a brief review of the main Sigmund products for industrial and chemical processes, oil refineries, water supply, drainage, sewage disposal, fire fighting, civil engineering, mining and contractors, irrigation, etc., and then goes on to show some actual industrial installations. Chemical pump installations are shown handling organic solvents, caustic solutions, hydrocarbons, ethylene chloride and other materials. The company's testing facilities are also illustrated.

**Silicone rubbers,** to all outward appearances, possess all the characteristics of natural and other synthetic rubbers. They are elastic, and can be moulded, extruded, calendered and knife- or dip-coated. Where silicone rubbers come into their own is in operation at high and low ambient temperatures that would decompose or embrittle conventional rubbers. A 30-page illustrated booklet explaining the grades and properties available, and their applications in industry, is available from I.C.I. (Nobel Division), Silicones Department, Ardeer, Stevenston, Ayrshire.

**PTFE engineering.** Crane Packing Ltd. of Slough, Bucks., have recently published a 26-page booklet describing PTFE. Contents include processing of the basic raw material, moulding and extrusion, raw material forms, properties, material grades and their applications, PTFE components, dispersion coatings, the bellows pump, bellows, the *Fluoseal* and 'O' rings, etc.

**Glycerine** is an ingredient in over 1,700 processes and compositions, which are listed in a booklet issued by the U.K. Glycerine Producers' Association Ltd., 5 Bridewell Place, London, E.C.4, who point out that, in addition to these 'known' uses, glycerine is also incorporated in many undisclosed formulae.

**Variable-speed gears.** Leaflet DFC/2 from Carter Gears Ltd., Thornbury Road, Bradford 3, Yorks., gives details and dimensions of the hydraulic relay speed control for 'F' type Carter hydraulic infinitely variable speed gears. This is intended as a guide to potential users and includes notes on the application of this particular control in cases where only light operating forces are available. It should be read in conjunction with current technical publications on the 'F' type gears.

**Spray coating.** B.E.N. Patents Ltd., P.O. Box 10, High Wycombe, Bucks., have issued a leaflet on their model OS automatic spray gun, with particulars of a typical set-up for automatic spraying.

**Metal products.** The Metals Division of I.C.I. describe in a pamphlet a number of their specialised non-ferrous metal products for the chemical and petroleum industries including integral finned heat-exchange tubing, wrought titanium and titanium alloys, welding rods, aluminium and aluminium alloys. The pamphlet is available from I.C.I. at P.O. Box 216, Birmingham 6.

**Stoneware.** Doulton Industrial Porcelains Ltd., Wilnecote Works, near Tamworth, Staffs., have brought out a general catalogue of a representative range of their many products for chemical and industrial use. Some of the items included are mixing and storage vessels, cocks, pipelines and fittings, vacuum filters, grinding equipment, absorption and condensing towers and accessories, and laboratory equipment.

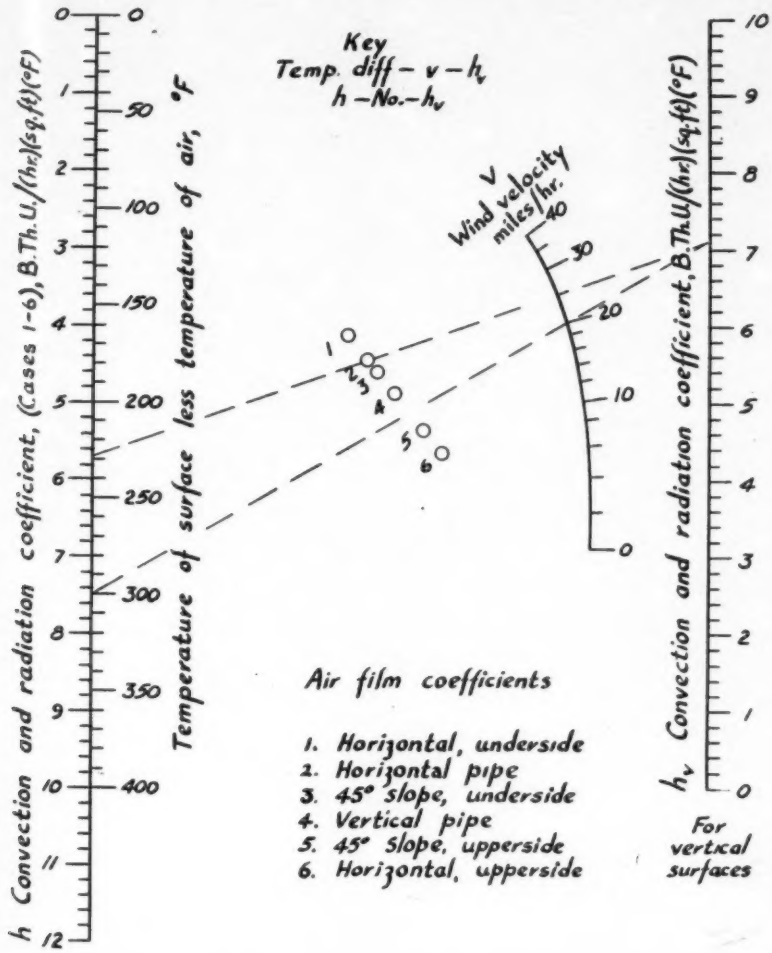
**Opportunities for graduates.** A booklet describing the opportunities within the group for graduates with a degree in chemistry or chemical engineering is available from Albright & Wilson Ltd., P.O. Box 3, Oldbury, Birmingham.

**'Meehanite' castings,** their varied uses and physical properties, are the subject of a brochure issued by Ashmore, Benson, Pease & Co., Stockton-on-Tees.

# Convection and Radiation Coefficients for Air Films

**By D. S. Davis**

*(Head, Department of Pulp and Paper Technology, University of Alabama)*


Key
Temp. diff – v – $h_v$
h – No. – $h_v$
v
Wind velocity miles/hr.
Temperature of surface less temperature of air, °F
h Convection and radiation coefficient, (Cases 1-6), B.Th.U./(hr.)(sq.ft)(°F)
$h_v$ Convection and radiation coefficient, B.Th.U/(hr.)(sq.ft)(°F)
For vertical surfaces
Air film coefficients
1. Horizontal, underside
2. Horizontal pipe
3. 45° slope, underside
4. Vertical pipe
5. 45° slope, upperside
6. Horizontal, upperside

Computation of heat losses from exposed vertical surfaces to air requires reliable estimates of combined convection and radiation coefficients, which depend upon the velocity of the air and the difference in the temperatures of the surface and the air. Such coefficients are practically the same for vertical wood, metal, brick, canvas and asbestos surfaces and can be adjusted to include pipes and plane surfaces in various positions.[1]

The accompanying nomogram enables rapid and accurate estimation of these coefficients. The use of the chart, which was constructed in accordance with well-known methods,[2] is illustrated as follows: What is the combined convection and radiation coefficient for a vertical surface which is 300°F. warmer than surrounding air in motion at 20 miles/hr. ? Follow the key; connect 300 on the temperature difference scale and 20 on the *v*-scale with a straight line. Extend the line to the $h_v$-scale at the right and read the desired coefficient as 7.1 B.Th.U. (hr.) (sq. ft.) (°F.).

Under these same conditions, what would be the convection and radiation coefficient for horizontal pipe ? Connect 7.1 on the $h_v$-scale and point No. 2 (for horizontal pipe) with a straight line. Extend the line to the *h*-scale at the left and read the desired coefficient as 5.7 B.Th.U. (hr.) (sq.ft.) (°F.).

REFERENCES

[1]W. L. Nelson, ' Petroleum Refinery Engineering,' 3rd edition, pp. 495-496. McGraw-Hill Book Co. Inc., New York, 1949.

[2]D. S. Davis, ' Nomography and Empirical Equations,' Chapters 7 and 10. Reinhold Publishing Corporation, New York, 1955.

# MEETINGS

### Institution of Chemical Engineers

*January* 20. ' Separation of Isotopes by Molecular Distillation,' by P. T. Nettley, 7 p.m., Blossoms Hotel, Chester.

*February* 3. ' Effluent Disposal and Air Pollution,' 3 p.m., College of Science and Technology, Jackson Street, Manchester.

*February* 7. ' Principles of Selecting Dimensional Systems and Units in Chemical Engineering,' by A. Klinkenberg, 2.30 p.m., Birmingham College of Technology, Gosta Green, Birmingham.

### Chemical Society

*January* 8. ' Fluidisation,' by J. F. Richardson, 7.30 p.m., North British Hotel, Edinburgh.

*January* 22. ' The Acetylenic Approach to the Synthesis of Natural Products,' by Prof. R. A. Raphael, 4.30 p.m., The University, Sheffield.

*January* 27. ' The Use of Deuterium in the Study of Catalytic Hydrogenation,' by Prof. C. Kemball, 7.30 p.m., Biochemistry Lecture Theatre, Teviot Place, Edinburgh.

### Society of Instrument Technology

*January* 7. ' Instruments for Flame Radiation and Heat Transfer Measurements,' by Prof. M. W. Thring, 7 p.m., The University, Sheffield 1.

*January* 9. ' Pilot Plant Instrumentation,' by M. F. Binney, 7 p.m., Regent House, St. Phillip's Place, Colmore Row, Birmingham 3.

*January* 30. ' Measurement of Temperature Using Fuel Systems,' by D. T. Royce, 7.15 p.m., Scottish Building Centre, 425 Sauchiehall Street, Glasgow.

### Institute of Metals

*January* 8. ' Metallurgical Education in the U.S.S.R.,' by I. G. Slater, 6.30 p.m., College of Technology, Gosta Green, Birmingham.

*January* 13. ' The Zinc Blast Furnace,' by S. W. K. Morgan, 6.30 p.m., University College, Singleton Park, Swansea.

### Institute of Petroleum

*February* 4. ' Chlorination of Salt Cooling Water at Coryton,' by D. H. Tullis, A. T. Henderson and L. C. Neill, 5.30 p.m., 61 New Cavendish Street, London, W.1.

# Company News

Ray-Heet (Infra-Red) Ltd. has become a member of the Vokes group of companies. It will trade under the new name of Ray-Heet (Process Plant) Ltd. with offices at Rayleigh House, High Street, Great Bookham, Surrey. It will offer a range of process plant including: degreasing, cleaning and chemical pretreatment plant; spray booths; paint-dipping plant; flow-coating plant; electrostatic painting plant; infra-red (gas-fired) convection ovens; and cooling tunnels for reducing the cooling time after stoving.

*

Mobil Oil Co. Ltd. report that Constructors John Brown Ltd. are well advanced with the building of a large liquefied petroleum gases recovery unit at the Coryton refinery.

The first stage of the plant is expected to be ready this month and Mobil will then be separating a substantial quantity of propane from the gases produced during normal refining operations. Later in the year the plant will also enable butane to be separated and stored for re-delivery to customers.

*

As part of the long-term reorganisation of the A.E.I. Group, Siemens Edison Swan Ltd. are to be divided into three divisions: cables, telecommunications and radio, and electronic components. Controlling these divisions will be Mr. J. S. A. Bunting, Mr. W. G. Patterson and Mr. J. W. Ridgeway who will hold appointments on the board of A.E.I. Divisional Management Co. Ltd.

*

Production and possibilities of some of the newer materials such as *Permaflon*-processed PTFE, which has very high temperature resistance, chemical inertness and other properties, and *Permaglass* glass-fibre reinforced laminates, are illustrated in a new film of Permali Ltd., which shows how several manufactures of the group, including densified wood laminates, high-voltage bushings and plastic products, have been concentrated into one large, modern factory at Gloucester.

In the process plant, 100-ft. bays facilitate logical layout with no interfering stanchions to waste space and baskets of veneers flow round the loading, impregnation, evaporation and unloading sequence with the minimum delay. In the press section there is one of the largest concentrations of high-pressure laminating plant in Britain. The hydraulic presses have been fitted with special control, heating and cooling equipment, making them interavailable for all densified wood products manufactured.

*

Jacobson Van Den Berg & Co. (U.K.) Ltd. announce that their principals, Pittsburgh Plate Glass Co., have established a new wholly-owned international subsidiary to be known as Pittsburgh Plate Glass International S.A., a Swiss corporation with its home office in Geneva. The purpose of the subsidiary is to integrate all phases of international business of the Pittsburgh Plate organisation, including licensing, investment, manufacturing and marketing functions.

It is expected that the overseas operations of Pittsburgh Plate Glass Internatonal eventually will include facilities for the production of glass, paints, chemicals and related products.

*

Sturtevant Engineering Co. Ltd. has created within its central organisation a cathodic protection department headed by Mr. J. H. Morgan who has recently joined the company.

*

Seven 200-litre glass flasks are among equipment being supplied by Q.V.F. Ltd. for a Russian factory which will manufacture cellulose acetate yarn. The flasks are being supplied to Courtaulds Ltd. who recently concluded a contract with Technopromimport of Moscow to supply machinery for the factory, which will use Russian-made raw materials.

*

Albright & Wilson's Canadian subsidiary, Electric Reduction Co. of Canada Ltd., announce that a new division, Erco Engineering Services, has been established to design, construct, install and start up tailor-made chlorine dioxide plants for pulp bleaching or other uses.

*

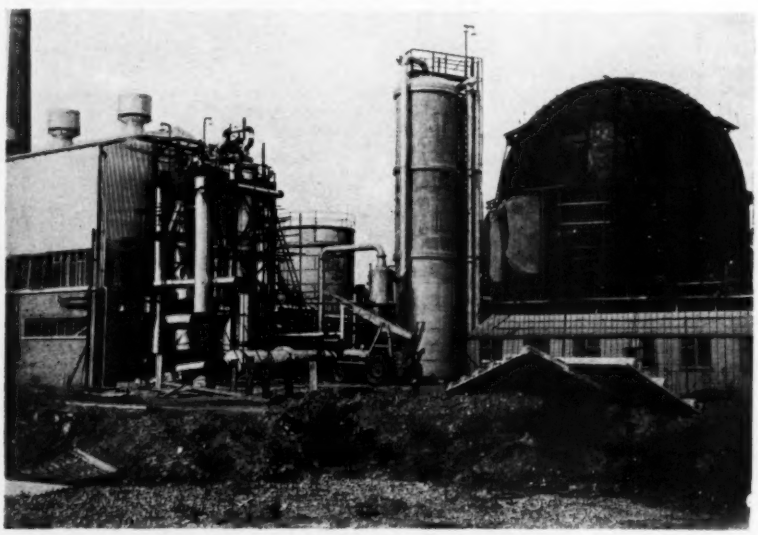
Evershed & Vignoles Ltd. have opened a district office at 14 Yarm Lane, Stockton-on-Tees. This office will be in the charge of Mr. W. H. M. Hoyle.

The company's northern area office at 116 Manningham Lane, Bradford 8, will continue to hold an overall responsibility for the northern counties and in addition has a staff of engineers for servicing products on site.

*

New plant for the production of castor fatty acids has recently been commissioned by Price's (Bromborough) Ltd. Employing soda saponification, the plant is primarily designed to produce 12-hydroxystearic acid (hydrogenated castor oil fatty acids). This is used for the manufacture of multi-purpose lithium-based grease and also in the production of alkyd resins, for plasticising urea and melamine/formaldehyde resins for stoving finishes, and esters for the cosmetics industry.

The plant will also be able to produce tung oil fatty acids in commercial quantities.



**Fisons' new nitrogen fac tory at Stanford-le-Hope, nearing completion (see December issue, page 454). On the right is the 2,000-ton capacity ammonia storage sphe re, and next to it the absorption column.**

# World News

### NETHERLANDS

**Carbon black and petroleum**

The Ketjen Sulphuric Acid Works of Amsterdam have announced that they will construct a 13-million-florin factory in the Botlek area, near Rotterdam, for the manufacture of carbon black. The new factory will be situated close to the oil refineries there which can supply the necessary raw materials. The new company will be named Ketjen Carbon and will work under a licensing arrangement with the American firm Godfrey L. Cabonet Inc., of Boston. The new company plans to sell its products in all parts of the world and will have an initial capacity of 13,000 tons of carbon black annually.

Another project under way in the Botlek area is the building of a new Esso petroleum refinery, and Werkspoor of Amsterdam, in conjunction with Stork of Hengelo, have been given a large order for mechanical plant to be installed in the refinery. The main construction and design work is being carried out by Badger-Comprimo N.V.

**Synthetic fibre and yarn**

A new factory of the Algemene Kunstzijde Unie N.V. was officially opened at Emmen recently. It is to manufacture a new type of synthetic fibre and yarn, *Terlenka*.

When the A.K.U. was given, by Imperial Chemical Industries Ltd., the right to manufacture polyester yarns and fibres in the Benelux countries four years ago, a pilot plant was established which produced the first *Terlenka* fibre in September 1955. Construction of the large-scale factory started in the autumn of 1957. It is expected that about 170 people will be employed.

### FORMOSA

**Soda ash factory**

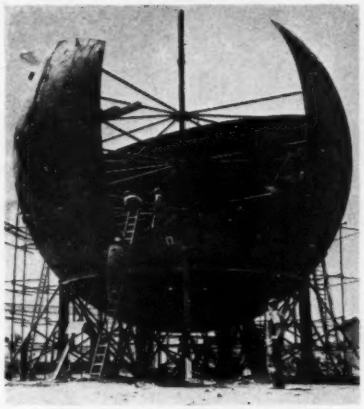
A new soda ash factory for the Tung Nan Alkali Corporation is being built at Suao, on the east coast of Formosa, to the designs of a West German engineering firm, and will incorporate West German machinery. The factory is expected to begin production in July.

### SOUTH AFRICA

**Heavy chemicals and solvents**

Production of methanol at Modderfontein and expansion of chlorine production are involved in the latest expansion plans of African Explosive & Chemical Industries Ltd., according to a correspondent. There will be considerable extensions to the chlorine, solvents and plastics departments at Umbogintwini, Natal.

The new expansion programme involves the investment of £5 million, bringing the company's post-war investment outlay in the Union up to £45 million. It is expected that the methanol plant will be in operation in 1960 and that it will be capable of producing 10,000 tons p.a.



**CHEMICAL ENGINEERING IN ISRAEL**

**Seen here under construction is the big ammonia sphere for Fertilizers & Chemicals, Haifa, mentioned in our 'Topics of the Month' in December.**

### AUSTRALIA

**Vinyl acetate**

The vinyl acetate plant of C.S.R. Chemicals Pty. Ltd. at Rhodes, New South Wales, built with technical assistance from British Celanese Ltd., is operating at a higher rate of output and efficiency than was specified in the contract.

The plant started production last August in advance of the contract date and should meet Australian demand for vinyl acetate for some years. The cost of the project has been put at approximately £A500,000. The bulk raw materials used are acetic anhydride and acetaldehyde which are made in other C.S.R. chemical plants from alcohol derived from sugar cane molasses.

### UNITED STATES

**Boron trichloride**

An agreement has been concluded between Dow Chemical Co. and United States Borax Research Corporation, a wholly owned subsidiary of United States Borax & Chemical Corporation (the operating company in the U.S.A. of Borax (Holdings) Ltd.), to engage in a joint venture to perfect an economic process for the manufacture of boron trichloride.

Boron trichloride, derived from boron and chlorine, is a highly reactive intermediate from which many of the newer boron compounds can be made. Dow and U.S. Borax have both been engaged for some time independently on research in this field.

### HUNGARY

**Chemical projects**

Work begins this year on the building of the superphosphate plant of the Tisza region chemical works, and the Borsod integrated chemical plant is to be further expanded. A lacquer factory using synthetic resin as a basic material is to be built at the Tisza plant to satisfy home requirements for lacquer dyes.

Also scheduled for 1959 is the construction of a PVC plant with a 6,000-ton annual capacity at the Hungaria chemical works, and a 10,000-ton sodium hydroxide plant.

The Borsod integrated chemical plant fulfilled its production plan for the year by November 11 with an output of 40,000 tons. It was expected that by the end of the year 10,000 tons more would bring the total to the equivalent of a million sacks, giving the country almost 50% more artificial nitrogenous fertiliser than was previously available.

Production started in May 1958 with half the factory working; full production was attained in September.

### HONDURAS

**Industrial projects**

A new cement plant is being built at Rio Bijao, near San Pedro Sula, for Cementos de Honduras S.A. by a consortium of engineers, both foreign and Honduran. Machinery is being supplied by the Allis-Chalmers Co., U.S.A.

Other new ventures still in the exploratory stage are a salt refinery in

£ s d

**CHEMICAL PLANT COSTS**

Cost indices for the month of November 1958 are as follows:

| | |
|---|---|
| Plant Construction Index: | 179.0 |
| Equipment Cost Index: | 165.9 |

(June 1949 = 100)

£ s d

the Gulf of Fonseca area, a rubber and chicle gum industry in Olancho, and an ice-making plant in Olanchito. The cellulose plant, construction of which has been under consideration for many months, has been held up through disagreement over siting, financing, and marketing of products.

### MALAYA

**Cement increase**

With a second cement kiln recently installed, Malaya Cement Ltd., the only cement factory in the Federation, is capable of producing 200,000 tons of cement annually. The Federation consumes about 300,000 tons of cement and the company hopes eventually to be in a position to supply the whole.

### MEXICO

**Freon gas plant**

DuPont S.A. de C.V. have announced the award of a contract to Bufete Industrial S.A. for the construction of a freon gas plant in connection with the titanium oxide plant which the same firm has contracted for near Tampico, Tamaulipas. The production will be used in the refrigeration industry and in the filling of aerosols.

# Personal Paragraphs

★ Nuclear Chemical Plant Ltd., the company formed jointly by the Power-Gas Corporation Ltd., Humphreys & Glasgow Ltd. and John Thompson Ltd., announce the appointment of **Mr. R. W. Rutherford** (joint deputy managing director of Power-Gas) as chairman and **Mr. C. G. Farthing** (deputy chairman and joint managing director of Humphreys & Glasgow) and **Mr. J. H. N. Thompson** (deputy chairman and joint managing director of John Thompson) as directors. **Mr. C. J. Carter,** a director of John Thompson-Kennicott Ltd., **Mr. C. Robson,** a director of Power-Gas, and **Mr. N. H. Williams,** a director of Humphreys & Glasgow, are appointed alternate directors.

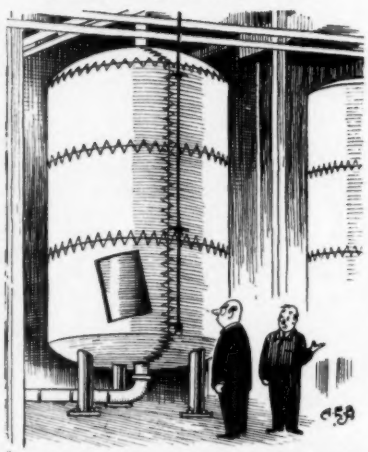
★ The death was recently announced, after a short illness, of **Mr. F. R. Stagg,** deputy chairman of Thos. W. Ward Ltd. He joined the company in 1895 as an office boy and by 1906 he had taken over management of the constructional department. He was appointed a local director in 1919 and a director in 1927. In 1938 he was made assistant managing director and became deputy chairman in 1950.

Although Mr. Stagg had relinquished several of his directorships of subsidiary and associated companies he was, at the time of his death, chairman and managing director of the Ketton Portland Cement Co. Ltd., Thomas Smith & Sons (Rodley) Ltd., John Smith (Keighley) Ltd., Widnes Foundry & Engineering Co. Ltd. and the Shap Granite Co. Ltd. He was alternate chairman, and also managing director, of Ribblesdale Cement Co. Ltd. and its subsidiaries.

★ **Mr. A. Carr,** assistant managing director of Thos. W. Ward Ltd., has been appointed deputy chairman. He joined the company in 1915, was appointed local director in 1936 and was elected a director in 1941, becoming resident London director in 1941. He returned to head office as assistant managing director in January 1954. He is also chairman and director of a number of companies of the Ward group at home and abroad. The company also announce the appointment of **Mr. D. F. Walton** as a director of Thos. W. Ward Ltd.

★ **Mr. H. Greville Smith,** C.B.E., president of Canadian Industries Ltd., has resigned from the board of the company. He joined the former Canadian Industries Ltd. in 1932 and was elected president of that company in April 1951. He continued as president of the present Canadian Industries Ltd. when it was formed in 1954. **Mr. P. C. Allen,** a director of Imperial Chemical Industries Ltd., England, has been appointed to fill the vacancy.

**Comical Engineering Corner**



"WELL, I DID OVERHEAR PERKINS SAY HE'D PROMISED HIS WIFE AN ELECTRIC BLANKET"

★ **Dr. W. H. McAdams,** emeritus professor of chemical engineering at the Massachusetts Institute of Technology, has received the gold medal of the French Institute of Fuels and Energy. The award was established by the French Institute to recognise the most distinguished achievements in the utilisation of fuels and thermal energy.

★ **Mr. J. Frisken,** a member of the Council of the Fertiliser Society, has been elected vice-president in succession to **Mr. A. I. Coleman** who has resigned after finding it necessary to reduce his commitments, temporarily, owing to ill health.

★ **Mr. A. P. Marsden** has been appointed traffic manager of Union Carbide Ltd. This department has been formed to deal with the centralisation of the alloys and chemicals divisions of Union Carbide and the present expansion plans. Mr. Marsden has for many years been assistant sales manager in the chemical sales division. **Mr. P. W. Lucas** has been appointed sales office manager of the chemicals division. He was formerly a senior purchasing officer with Bakelite Ltd., where he was primarily responsible for the purchasing of imported raw materials.

★ **Mr. R. C. Dickie,** works general manager of Marchon Products Ltd., Whitehaven, has been appointed to the board of directors. He joined the company in 1946 as chief chemist. **Mr. O. Secher,** a director of Marchon Products Ltd. in charge of sales, has now been appointed to the board of Solway Chemicals Ltd., Marchon's subsidiary company. Both companies are members of the Albright & Wilson group.

★ **Mr. R. J. Wingrove** has been awarded the William Macnab Medal of the Institution of Chemical Engineers for 1957. It is awarded annually for the best set of answers in the Associate Membership examination of the Institution. After obtaining his M.Sc. for research in chemistry Mr. Wingrove was a part-time student at the Battersea Polytechnic from 1954 until he completed the Institution examination in 1957. He started his career as an assistant chemical engineer with Head Wrightson Processes Ltd. and then spent several years as a chemist in the Fulham research laboratory of the North Thames Gas Board. In July 1958 he joined the drier and gas plant division of Birlec Ltd. as a project engineer and has since been working on the design of gas generators.

# Recent British Patents

### Activated alumina

Highly activated alumina is produced, by the process of the invention, from industrial alpha aluminium trihydrate, such as that produced by the Bayer process. The essential feature of the process is that the aluminium trihydrate is projected in powder form into a current of hot gas for a contact time of the order, preferably, of a fraction of a second. The gas and the activated alumina produced are separated in the reaction apparatus, shown in a drawing, by the principle of a cyclone. The temperature of the gas is between 400 and 1,000°C. The proportion of alumina trihydrate treated is between 20 and 150 g./cu.m. of gas.

The product has a water content of between 0.1 and 0.02 molecule per molecule of alumina, and a specific surface area of from 125 to 230 sq.m./g. It is stated to retain its adsorbent power after prolonged heating at temperatures of the order of 500°C.—801,462, *Pechiney Compagnie de Produits Chimiques & Electrometallurgiques (France)*.

### Distillation process and plant

In separating unreacted monomers after copolymerisation reactions, steam distillation is necessary to remove the less volatile monomer from the crude polymer latex. Much trouble is caused by frothing. To overcome this difficulty, a distillation column has been designed in which a small upper section is shut off by an imperforate plate of conical shape provided with a central pipe and a liquid transfer conduit. Part of the steam is used to treat the crude polymer in a vessel separate from, but communicating with, the distillation column. The mixture is caused to impinge on the inside of the column in the upper space. The impact disrupts the foam formed. Thereafter the liquid passes down the column, meeting additional ascending steam in countercurrent flow.

If the unconverted monomers are butadiene and styrene, the whole apparatus is maintained under vacuum. While the latex is in the upper portion of the column much evaporation of monomers occurs. The latter are condensed and separated in the usual way. In the main part of the column some secondary foaming takes place on contact between the latex and the additional steam. In consequence some of the latex may be carried back up the column with the distillate. The mixture passes through the central pipe of the imperforate plate into the upper section of the column, impinging on the inner wall with the incoming mixture of latex and steam. Two sheets of drawings are appended to the specification.—802,148, *Dunlop Rubber Co. Ltd.*

### Fluid-bed roasting of zinc ores

The invention relates to the fluid-bed roasting of zinc ore concentrates, with special reference to the separation of lead or cadmium compounds or both. Unmodified fluid-bed operations have the disadvantage that either the cadmium and lead are retained in the zinc metal produced, or the temperature of separation is so high as to cause sintering. It is now claimed that at least 90% of the cadmium and lead can be removed without sintering by controlling the particle size and degrees of agitation in two fluid beds, the amount and distribution of roasting air, and the volatilising temperature.

The particle size of the zinc ore is from 4 to 65 mesh (Tyler standard), preferably from 6 to 20 mesh. This size is obtained by agglomerating finely divided material by known methods. The agitation relationship is governed by the fact that the cross-sectional area of the plant, shown in a drawing, is at least twice as great in the upper part as in the lower. The roasting air admitted is limited to form 80 to 90% of that theoretically required to oxidise the zinc sulphide. The volatilising temperature in the upper bed is from 1,050 to 1,100°C. The danger of sintering is further minimised by providing a grate at the bottom end of the plant.—800,643, *The New Jersey Zinc Co. (U.S.A.)*.

### Catalyst regeneration

During the hydrogen treatment of the gasoline, gas oil, and lubricating oil fractions of petroleum the catalyst becomes inactivated and needs reactivation. The catalysts used contain molybdenum. They may consist of molybdenum oxide supported on purified alumina substantially free from silica, or molybdenum sulphide or molybdenum trioxide, also on alumina. The catalyst inactivation is due to the accumulation of carbonaceous materials.

The regeneration process, illustrated by a diagram, consists of several steps. First, the contact of the petroleum fraction with the catalyst is discontinued, while that of the hydrogen is maintained until residual liquid petroleum is removed. Hydrogen is then shut off and steam passed over the catalyst to remove completely the petroleum fraction. Steaming is continued with increase of temperature to about 850°F. Oxygen is then mixed with the steam in sufficient quantity to burn off carbonaceous material and to provide a temperature not higher than about 1,000°F. The free oxygen supply is discontinued, but steam treatment is continued for a further 30 min., after which it is stopped and hydrogen again passed over, the catalyst temperature being reduced to the range of about 500 to 750°F., when restoration of activity is completed to the extent of 85 to 95% of the original.—801,090, *Esso Research & Engineering Co. (U.S.A.)*.

### Lead alloys for accumulators

Alloys of lead and antimony used for grids of accumulator batteries often contain added arsenic to improve the corrosion resistance. To achieve this result, the proportion of arsenic necessary is considered too high. It has been proposed to reduce this by the addition of a small proportion of silver. The present invention is claimed to provide an improved corrosion resistance with the use of relatively little arsenic, by the incorporation of a small proportion of copper. A typical alloy contains between 2 and 20%, preferably from 5 to 8%, of antimony, from 0.075 to 1% of arsenic, and from 0.04 to 0.12% of copper, the balance being lead.

A new alloy of the above type is stated to have a 75% longer life when used in a cell grid than a known lead-antimony alloy containing 8% of antimony. While it is preferred to use such alloys for negative grids, they may also be used for positive grids.—802,825, *Accumulatoren-Fabrik A.G. (Germany)*.

### Liquefaction of gases

A process for liquefying gases already stored under high pressure depends on the Joule-Thomson effect which, for most gases, consists of a fall in temperature when a highly compressed gas is allowed to emerge through a small orifice.

In a diagram of the plant two cylinders are made of lightweight material of low heat capacity, and con-

taining gas under high pressure. They are also insulated. The gas from the first cylinder is discharged through a valve and passes to a heat exchanger where it is cooled by low-pressure gas leaving a receiver. On leaving the heat exchanger the gas is expanded through another valve where it is further cooled by the Joule-Thomson effect, some liquefaction taking place. The liquid gas collects in the receiver and the residual gas, now at low pressure, flows to the heat exchanger previously mentioned, where it takes heat from the high-pressure gas stream. It next passes through a coil in contact with the gas in the second cylinder, which is thus pre-cooled before passing into the liquefaction system.

The liquefaction coefficient for oxygen stored at 250 atm. pressure is claimed to be about 20%, compared with about 12% by earlier methods. It is recommended that the cylinders, of light weight and low heat capacity, be constructed of such a material as glass fibres reinforced by resin.—800,267, *The British Oxygen Co. Ltd.*

### Bonding rubber to metal

To bond natural or synthetic rubber to metal, the latter is coated with a resin obtained by condensing a phenol with an aldehyde, and containing a reactant for the formation of a polyhydroxyphenol-aldehyde resin. A vulcanisable rubber composition containing a further reactant, or a compound capable of generating such, which can react with the first reactant to form a polyhydroxyphenol-aldehyde under vulcanising conditions, is applied to the resinous layer. The rubber composition is then vulcanised.

The reactant in the resinous coating is a free polyhydroxyphenol such as resorcinol or phloroglucinol, preferably the former. Any aldehyde, or substance generating an aldehyde, may be the reactant of the rubber layer. The volatility of formaldehyde, if it is desired to use it, is overcome by using one of its solid polymers, such as paraformaldehyde. Suitable aldehyde generators are hexamethylene tetramine and aldehyde-ammonia. The proportions of the two reactants may be varied widely. Generally, that of the polyhydroxyphenol is from 25 to 200% of the phenol aldehyde resin, while that of the aldehyde or generator is from 10 to 50% of the rubber composition.

In an example, a metal plate was coated with a 12% solution, in methyl ethyl ketone, of a phenol-formaldehyde resin containing a proportion of free resorcinol. To the coating thus obtained there was applied a coating consisting of 100 parts of natural rubber, 50 of carbon black, 5 of zinc oxide, 2 of stearic acid, 2.5 of sulphur, and 0.8 part of mercaptobenzothiazole, with a proportion of paraformaldehyde or hexamethylene tetramine. The proportions of the 'reactants' is shown in a table with the results of adhesion tests. The rubber composition was applied in a 10% solution in ethylene dichloride. Finally a layer of the above rubber composition, free from reactant or solvent, was applied to the coated surface. The assembly was heated in a mould for 20 min. at 307°F.—801,928, *Dunlop Rubber Co. Ltd.*

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### The Leonard Hill Technical Group—January

*Articles appearing in some of our associate journals this month include:*

**Manufacturing Chemist**—Instrumentation Progress; Computers and Process Control; The Burma Pharmaceutical Industry; Essential Oils from the Belgian Congo.

**Petroleum**—Fire Protection with Berthed Tankers; Oilfield Development; Nitroparaffins as Engine Fuel; Utilisation of Residual Fuel Oil; Coking Tendencies of Lubricating Oils.

**Paint Manufacture**—Raft Trials for underwater paints, 2; New resin plant for Venezuelan paint factory; Paint courses at Birmingham College of Technology; Instrumental Control of Temperature; Instruments for Paint Testing.

**Atomic World**—Nuclear Energy in Italy; Measuring Machine Tool Wear by Isotopes; Processing Advanced Reactor Fuels; Nuclear Fuel Cycles; How Do They Pick a Nuclear Power Station Site?

**Food Manufacture**—Mushrooms by the Million; The Bacterial Population of Fresh, Healthy Cucumbers; Quality Control of Packaging Materials.

**World Crops**—The State of World Agriculture; Special Smithfield Supplement; Seychelles Vanilla, 2; Hillside Tractors; The Budapest Fair; Self-Help in China.

**Corrosion Technology**—Corrosion Research Laboratories, 14; Pipeline Corrosion in the Middle East; Refinery Corrosion due to Crude Oil; Corrosion Problems in Singapore.

**Fibres**—Synthetic Detergents in Textiles; Choice and Evaluation in Industrial Research.

## CONTRACTS

A special vacuum plant for Czechoslovakia to be used in the freeze-drying of large quantities of streptomycin has been completed by Edwards High Vacuum Ltd. The complete equipment was required to process 300 litres of streptomycin salt daily and the plant was designed to handle this amount in 22-hr. cycles.

The vacuum drying section of the plant consists of three identical drying chambers, each cylindrical with a vertical axis and in two sections. The upper part of each chamber comprises a metal bell which can be raised or lowered on a cable by means of a hoist. When lowered and in position this part of the chamber contains a vertical stack of 10 shelves with a total shelf area of 110 sq. ft., the spacing between the shelves being approximately 3½ in. Each shelf supports four stainless-steel trays complete with lids, so arranged that they permit a flow of vapour while providing a trap for air-borne bacteria. Each lid contains a filling hole and a further hole to accommodate a sheathed thermocouple junction for measuring temperature.

The lower section of each drying chamber is supported within a sealed cabinet mounted at floor level.

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Two Wellman hot metal mixers, each of 800 tons capacity, are being shipped to India for the £100-million steelworks at Durgapur. Newton Chambers & Co. Ltd. fabricated the structural steelwork for and to the designs of the Wellman Smith Owen Engineering Corporation. Each mixer involves some 188 tons of structure and has an outside shell diameter of 21 ft. 3½ in. and a length of 37 ft. Recently one of the mixers successfully underwent an assembly proving process to ensure that no serious difficulties would be encountered during its final erection in India.

Newton Chambers are also making for Durgapur, as sub-contractors to Wellman Smith Owen, a large number of ingot casting cars, four-wheel charging box bogies, charging boxes, and the structural steelwork for six 150-ton ladle cranes.

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Head Wrightson Stockton Forge Ltd. have received an order from Titania A/S., Norway, for the supply of a special-type Class H. 18 rotary drier 104 in. × 70 ft. long. It is to be used for the drying of ilmenite in a new titanium ore concentrates plant to be located at Telnes in S.W. Norway, a few miles from Jossingfjord.